South Brunswick School District

HIGH SCHOOL CORE SCIENCE

Parent Guide

Date of Last Curriculum Revision: August 2012

District Mission
The South Brunswick School District will prepare students to be lifelong learners, critical thinkers, effective communicators and wise decision makers. This will be accomplished through the use of the New Jersey Core Curriculum Content Standards (NJCCCS) and/or the Common Core State Standards (CCSS) at all grade levels. The schools will maintain an environment that promotes intellectual challenge, creativity, social and emotional growth and the healthy physical development of each student.

~Adopted 8.22.11

Curriculum Aligned to NJ Core Curriculum Content Standards (NJCCCS)
Board Approval of Science Curriculum
August 2016

This curriculum is approved for all regular education programs as specified and for adoption or adaptation by all programs including those for Special Education, English Language Learners, At-Risk Students and Gifted and Talented Students in accordance with Board of Education Policy.
Science Acknowledgments
We are appreciative of the leadership provided by our curriculum specialists and the knowledge, skills, work and effort of the teachers who served on our curriculum writing teams. In many cases, our units are “home-grown.” While aligning with state and/or national standards, they are designed with the needs of the South Brunswick student population in mind.

Articulation
The Supervisors, Specialists, Curriculum Chairpersons, Technology Staff Developers, Directors and the Assistant Superintendent for Curriculum and Instruction meet for articulation at regular roundtables and ongoing content meetings throughout the year.

Among the topics of discussion are the following: curriculum review cycle, curriculum mapping, resources (ordering, budgeting, inventory), lesson plans, observation look-fors, professional development, NJ Quality Single Accountability Continuum and academic achievement, placement, acceleration, enrichment, basic skills, instructional support, technology proficiencies and content-specific technologies, formative and summative assessments, and various curriculum tasks.

Science Curriculum Development Teams comprised of teachers along with representatives of special education meet together throughout the year as needed. In a time period of major revision, the teams will meet with greater frequency.

The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them. ~William Lawrence Bragg
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NOTE:
The curriculum for each level is “housed” under separate cover.

For every fact there is infinity of hypotheses.
~Robert M. Pirsig
Zen and the Art of Motorcycle Maintenance
Overview of Science Instruction

Mission Statement
It is the intention of South Brunswick Schools to graduate all of its students with the scientific knowledge, skills and habits of mind needed to be lifelong-learners, critical thinkers, effective communicators and wise decision-makers. Students will develop and use the skills necessary for full participation in a world shaped by science and technology.

Our vision is that all students will…

- Be curious about how the world works.
- Be scientifically honest, willing to reevaluate ideas when new data are presented.
- Respect the world around them and work to protect both the local and global environment.
- Understand that science is not a static body of knowledge but is continually evolving as new information emerges.
- Be able to evaluate scientific ideas from an historical perspective.
- Be adept in the use of electronic technology, choosing the appropriate technology for the problems and tasks with which they are confronted.
- Be able to apply knowledge, skills, and processes from science, math, and technology to solve complex, real-world problems.
- Be tenacious in solving problems.
- Be able to use reason and relevant data to support conclusions and opinions.
- Be able to effectively communicate scientific ideas and information orally, visually, and in writing using a variety of medium.
- Be able to work effectively independently and interdependently to solve problems.

Best Instructional Practices in Science

Effective classroom teachers:

1. Help students develop scientific Habits of Mind.
   An effective science experience will foster student’s natural curiosity about the world around them, encourage students to be open to new ideas and promotes appropriate skepticism.

2. Help students to use scientific thinking skills.
   An essential element for a student to be a scientific investigator is knowing how to find answers to questions. The skills of scientific inquiry include questioning, hypothesizing, observing, experimenting, measuring, interpreting data, drawing conclusions, and communicating findings.

3. Make science part of everyday life in the classroom.
   Science isn’t a subject that just happens once or twice a week. By making materials available, modeling scientific thinking, and responding to events that occur in the environment, science is part of everyday life.

4. Provide materials to encourage scientific exploration.
   Include materials that are interesting to explore as part of the physical environment to create a setting in which students spontaneously ask questions and conduct both formal and informal investigations. Displays can consist of computer programs, videos, filmstrips, books, newspaper articles, and magazines related to particular topics,
creations made by children, and objects collected by the teacher or students. A tank of fish, hermit crabs, turtles, or a frog can be a catalyst for ongoing science discussions and observations.

4. Provide tools for scientific investigations.
   An important part of science is becoming familiar with the **purposeful use of tools** and beginning to recognize the way tools relate to mathematical and scientific thinking. Some tools such as scales, measuring cups, thermometers, calculators, and rulers are for measuring. Other tools such as magnifiers, microscopes, and cameras aid observation.

5. Serve as scientific role models.
   **Model scientific thinking** by being observant and pointing out specific events when they happen. For example, when water forms on a glass, you might ask, “What do you think is happening here? What’s causing the water to form on the glass?” The goal is to encourage children to be curious and consider cause and effect. By inviting students to talk about their experiences or discoveries and encouraging the others to ask questions, teachers help students think like investigators.

6. Select topics for long-term studies in science.
   Students learn best by having time for **extensive exploration** of a few topics during the year. It is a good idea to resist the temptation to touch briefly on many topics. Select topics that allow students to conduct first-hand research and use scientific thinking skills. Because you can only do so much, you will also want to consider which topics provide natural linkages to other subjects you will be studying.

7. Have students work in a variety of settings.
   The **choice of settings** – cooperative groups, pairs of students, individuals, and whole groups – depends on the teacher’s objective and the specific content of the lesson. Students should be exposed to each kind of setting throughout the year.

   For example, use of classroom technologies such as interactive whiteboards, projection devices, digital hardware and software.

**Program Delivery**

Our Science classrooms are effective standards-based environments that foster understanding of big ideas and help students make connections between present, past and future. Below are the varied “Science paths” that students follow during their course of study in South Brunswick.

**Elementary School:**
- Kindergarten- The Five Senses and Our Big Backyard
- First Grade- Water; Forces/Pushes & Pulls; and Collecting and Examining Life
- Second Grade- Life Cycle of a Butterfly; Rocks & Soil; & Properties of Light
- Third Grade- Structures of Life; Water & Weather; & Earth, Sun and Moon
- Fourth Grade- Ecosystems; Matter and Energy; and Magnetism and Electricity
- Fifth Grade- Microworlds; Chemistry; Body Systems (joint science-health unit)

**Middle School:**
- Sixth Grade- Systems, Astronomy, Phylogenetics, and Geology
- Grades 7 and 8:
  - “A” Year: Life Systems, Chemistry, and Meteorology
“B” Year: Physics, Genetics, and Ecology

High School:
- Core Courses (3 years of science required for graduation):
  Physical & Earth Science; Physics I A (Alternative-Active), Physics I T (Traditional-Team based; College Prep), Physics- College H (Honors)
  Chemistry I (Community), Chemistry I (T), Chemistry (H)
  Elements of Biology, Biology I, Biology (H)
- Electives:
- Advanced Placement Courses (with prerequisites):
  AP Biology, AP Chemistry, AP Environmental Science, AP Physics B, AP Physics C
- Note: The following courses that extend beyond AP are now in the Mathematics Curriculum: Multivariable Calculus, Linear Algebra, Differential Equations, Cimplex Analysis, Analysis

Resources

**Elementary**

**Kindergarten**
- The Five Senses – *SB District Unit*
  - Also uses these books: Sense-Able Science, AIMS Ed. Foundation, 1994
  - Sense-Abilities: Fun Ways to Explore the Senses, Michelle O’Brien-Palmer, 1998
- Our Big Backyard – *SB District Unit*

**First Grade**
- Collecting & Examining Life – *Science Companion*
- Investigating Water – *DSMII kit*
- Balls and Ramps – *Insights Publications*
- Motion – *Science Companion*

**Second Grade**
- Pebbles, Sand, & Silt – *FOSS kit*
- Rocks – *Science Companion*
- Life Cycle of Animals – *SB District Unit* – *STC – Life Cycle of Butterflies*
- Light – *Science Companion*

**Third Grade**
- Structures of Life – *FOSS kit*
- Water – *FOSS kit*, Weather – *STC kit (Carolina)*
- Earth, Sun, & Moon - *SB District Unit*

**Fourth Grade**
- Magnetism and Electricity – *FOSS kit*
- Ecosystems - *SB District Units, GEMS, Terrarium Habitats*
- Matter and Energy – *FOSS kit*

**Fifth Grade**
- Microworlds – *STC*
- Chemistry & Density– *SB District Unit*
- Body Systems– *SB District Unit*
Middle School

Sixth Grade
Prentice Hall Science Explorer Textbooks
Phylogenetics- From Bacteria to Plants
Astronomy- Astronomy
Geology- Inside Earth
FOSS Kits-
Systems- Variable, Models and Designs

Seventh-Eighth Grade
Prentice Hall Science Explorer Textbooks
Chemistry- Chemical Building Blocks and Chemical Interactions
Life Systems- Animals and TBD
Meteorology- Weather and Climate
Ecology- Environmental Science
Genetics- Heredity: Cells and Heredity
Physics- Motion, Forces and Energy

High School
Physical & Earth Science- Science Spectrum, Holt
Physics I (A/T)- Conceptual Physics, Addison Wesley
Honors Physics- College Physics, Thomson/Brooks/Cole
AP Physics C: Mechanics- Reese, University Physics, Brooks/Cole
Chemistry I (CC)- Chemistry in the Community, American Chemical Society
Chemistry I (T)- Chemistry by Smoot etal, Glencoe/McGraw Hill
Chemistry I (T)- Chemistry by Wilbraham etal, Prentice Hall
AP Chemistry- Chemistry Principles and Reactions, Masterton & Herley
Biology I and II- The Web of Life, Addison Wesley
Honors Biology- The Web of Life, Addison Wesley
AP Biology- Biology by Campbell, Reece, Mitchell, AP edition-10th edition
AP Environmental Science- Environmental Science – Earth as a Living Planet by Botkin and Keller
Human Anatomy & Physics- Hole's Human Anatomy & Physiology 11th edition
SAMCLA DECA- Multivariable variable calculus, Stewart Linear Algebra
Assessment
There are multiple and varied forms of assessment at each grade level. What follows is a list of the key assessment tools used at each level.

Assessments at the Elementary Level
- Teacher made tests, quizzes and projects
- Recording of observations, journal keeping, presentations
- Performance assessments
- End of Unit assessments
- 4th Grade NJASK Science

Assessments at the Middle Level:
- Teacher made tests, quizzes and projects
- Lab reports
- Embedded performance assessments
- Pre and End of unit assessments
- 8th Grade NJASK Science

Assessments at the High School Level
- State end-of-course exam: NJ Biology Competency Test (NJBCT)
- Teacher made tests, quizzes and projects
- Labs- written reports (short and long form)
- Pre-Post Unit assessments
- Pre-Post Course assessments
- AP Exams

Core Curriculum Content Standards for Science
The South Brunswick Science Curriculum is aligned to the New Jersey Core Curriculum Content Standards. These standards are addressed at every grade level, and are supported by research findings about how students learn science. Our program is inquiry based, and learning is viewed as an active process in which students construct their understanding of the natural world by engaging in “hands-on” and “minds-on” experiences. Technology is embedded where meaningful, and connections to the 21st Century Life and Career Education standards, to the District’s core values, and to other areas of curriculum are purposely and explicitly noted.

Standard 5.1 Scientific Practices
All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

A. Understand Scientific Explanations
Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

B. Generate Scientific Evidence Through Active Investigations
Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

C. Reflect on Scientific Knowledge
Scientific knowledge builds on itself over time.

D. Participate Productively in Science
The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

**Standard 5.2 Physical Science**
All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

**A. Properties of Matter**
All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

**B. Changes in Matter**
Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

**C. Forms of Energy**
Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

**D. Energy Transfer and Conservation**
The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

**E. Forces and Motion**
It takes energy to change the motion of objects. The energy change is understood in terms of forces.

**Standard 5.3 Life Science**
All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**A. Organization and Development**
Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

**B. Matter and Energy Transformations**
Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

**C. Interdependence**
All animals and most plants depend on both other organisms and their environment to meet their basic needs.

**D. Heredity and Reproduction**
Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

**E. Evolution and Diversity**
Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.
Standard 5.4 Earth Systems Science
All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe.

A. Objects in the Universe
   Our universe has been expanding and evolving for 13.7 billion years under the influence of gravitational and nuclear forces. As gravity governs its expansion, organizational patterns, and the movement of celestial bodies, nuclear forces within stars govern its evolution through the processes of stellar birth and death. These same processes governed the formation of our solar system 4.6 billion years ago.

B. History of Earth
   From the time that Earth formed from a nebula 4.6 billion years ago, it has been evolving as a result of geologic, biological, physical, and chemical processes.

C. Properties of Earth Materials
   Earth’s composition is unique, is related to the origin of our solar system, and provides us with the raw resources needed to sustain life.

D. Tectonics
   The theory of plate tectonics provides a framework for understanding the dynamic processes within and on Earth.

E. Energy in Earth Systems
   Internal and external sources of energy drive Earth systems.

F. Climate and Weather
   Earth’s weather and climate systems are the result of complex interactions between land, ocean, ice, and atmosphere.

G. Biogeochemical Cycles
   The biogeochemical cycles in the Earth systems include the flow of microscopic and macroscopic resources from one reservoir in the hydrosphere, geosphere, atmosphere, or biosphere to another, are driven by Earth’s internal and external sources of energy, and are impacted by human activity.

The curriculum is written in the Understanding by Design format and is based on enduring understandings (broad concepts) with essential questions and both formative and summative assessments.

Complete copies of the standards for science may be found at:
New Jersey Core Curriculum Standards (NJCCS)
K-12 Curriculum Maps:  
*Development of science concepts over time*

Through funding provided by CONNECT-ED\(^1\), curriculum developers in South Brunswick have mapped the concepts that are studied as part of the K-12 science curriculum. Their work was informed by that done by the American Association for the Advancement of Science (AAAS) in its development of the *Atlas of Science Literacy*.

To provide context, the *Atlas of Science Literacy* is a compendium of conceptual maps based on science strands. The maps show how students’ understanding of the ideas and skills leads to literacy in science, mathematics, and technology— and shows how this development occurs over time, from kindergarten through 12th grade. The *Atlas* may be accessed at the AAAS homepage:  
[www.project2061.org](http://www.project2061.org)

Included in the SBSD Compendium of Science Maps are the South Brunswick School District maps of the science learning that takes place across the K-12 grade levels. There are four maps— each based on the New Jersey Core Curriculum Content Standards.

- Science Processes
- Earth Science
- Life Science
- Physical Science

Each map focuses on a core topic and then displays the K-12 benchmarks that are most relevant to understanding it. The map illustrates the benchmarks along the way—each building upon that which comes below and supporting that which comes after.

The compendium of maps can be found in the Science Companion Document.

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\(^1\) Established in 2003, CONNECT-ED is a Consortium of 14 central NJ districts/ independent schools, Rider and Princeton Universities, Raritan Valley Community College, Bristol-Myers Squibb Company, and the National Staff Development Council (NSDC) dedicated to providing a coherent, sustained system of professional development for K-12 teachers of science and math that **models the inquiry approach** to teaching/learning, **organizes content around the Big Ideas** in science and math, and makes concept connections across grade levels and among disciplines. South Brunswick is one of the fourteen districts involved, and has been a group member since the consortium’s inception.
SCIENCE CURRICULUM
## Elementary Matrix:
### NJ Core Curriculum Content Standards (NJCCCS) and Essential Questions

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<th>Grade</th>
<th>Standards &amp; Essential Questions by Grade Level</th>
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<tbody>
<tr>
<td>Kindergarten</td>
<td>Kindergarten students study life, earth and environmental sciences based on the NJCCCS 5.1.4.A.1-A.3, 5.1.4.B.1-B.3, 5.1.4.C.1, 5.1.4.C.2, 5.1.4.D.1, 5.1.4.D.4, 5.2.2.A.1, 5.3.2.A.1, 5.3.2.B.1, 5.3.2.B.3, 5.3.2.D.2, 5.4.2.E.1, 5.4.2.F.1, 5.4.2.G.3</td>
</tr>
<tr>
<td></td>
<td>- <em>The Five Senses</em> (life) ~ What are the five senses and what body parts are connected with each? How do the senses help us discover and interact with our environment? How do the five senses work alone and/or together?</td>
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<tr>
<td></td>
<td>- <em>Our Big Backyard</em> (earth/environment) ~ Where do we see/find nature? Why is nature important to us? What cycles and patterns do we see in nature?</td>
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<tr>
<td>First Grade</td>
<td>First Grade students study physical and life sciences based on the NJCCCS 5.1.4.A.1-A.3, 5.1.4.B.1-B.3, 5.1.4.C.1, 5.1.4.C.2, 5.1.4.D.1, 5.1.4.D.3, 5.1.4.D.4, 5.2.2.A.1, 5.2.2.A.2, 5.2.2.E.1-E.3, 5.2.4.E.1, 5.2.4.E.2, 5.3.2.A.1, 5.3.2.B.1-B.3, 5.4.2.E.1, 5.4.2.G.1-G.3</td>
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<td></td>
<td>- <em>Water</em> (physical) ~ What are the properties of water? How does water change from one form to another? Where is water found? Why is water important?</td>
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<td></td>
<td>- <em>Forces</em> (physical) ~ How do things move? How can we change the way things move? What evidence do we have of forces that we cannot see?</td>
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<tr>
<td></td>
<td>- <em>Collecting and Examining Life</em> (life) ~ How do we know if something is alive? What are the basic needs of living things? How do living things change over time? What parts do animals have to help them move, grow, breathe, eat, and sense their environment</td>
</tr>
<tr>
<td>Second Grade</td>
<td>Second grade students study the life, earth and physical sciences based on the NJCCCS 5.1.4.A.2, 5.1.4.A.3, 5.1.4.B.1-B.4, 5.1.4.C.1, 5.1.4.C.3, 5.1.4.D.1-D.3, 5.2.2.B.1, 5.2.2.C.1-C.3, 5.3.2.A.1, 5.3.4.A.2, 5.3.2.B.1, 5.3.2.B.2, 5.3.2.C.1-C.3, 5.3.2.D.1, 5.3.2.D.2, 5.3.4.D.1, 5.3.2.E.1, 5.3.2.E.2, 5.4.2.G.3, 5.4.4.B.1, 5.4.4.C.1, 5.4.4.C.2, 5.4.4.C.1, 5.4.4.C.2,</td>
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<td></td>
<td>- <em>Life Cycle of Butterfly</em> (life) ~ What changes do living things go through during their lives? How do living things affect their environment and how do changes in the environment affect living things?</td>
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<td></td>
<td>- <em>Rocks &amp; Soil</em> (earth) ~ What is the Earth made of? What makes up land? What do the rocks and soils around us look like? Why are rocks and minerals important resources? What is a fossil?</td>
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<td>- <em>Properties of Light</em> (physical) ~ What is light? What are the sources of light? How does light travel?</td>
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<tr>
<td>Third Grade</td>
<td>Third Grade students study the life, earth and physical sciences based on the NJCCCS 5.1.4.A.1-A.3, 5.1.4.B.1-B.4, 5.1.4.C.1-C.3, 5.1.4.D.1-D.3, 5.2.4.E.4, 5.3.4.A.1, 5.3.4.A.2, 5.3.4.B.1, 5.3.4.D.1, 5.3.4.E.1, 5.3.4.E.2, 5.4.2.A.1, 5.4.4.A.1-A.4, 5.4.4.E.1, 5.4.2.F.1, 5.4.4.F.1, 5.4.2.G.1, 5.4.2.G.2, 5.4.4.G.1-G.4</td>
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</table>
|            | - *Structures of Life* (life) ~ What properties do all living things have that make them similar? What properties do all living things have
<table>
<thead>
<tr>
<th>Grade</th>
<th>Standards &amp; Essential Questions by Grade Level</th>
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<tbody>
<tr>
<td></td>
<td>that make them different? How do different organisms meet their needs for survival?</td>
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<tr>
<td></td>
<td>• Earth, Sun, and Moon (earth) ~ To what extent are the properties of objects in our solar system predictable? What causes these patterns? What causes day and night? What causes the moon to appear to change shape? What are some properties of the Sun, moon and stars?</td>
</tr>
<tr>
<td></td>
<td>• Water &amp; Weather (physical/earth) ~ How do changes in one part of an Earth’s system affect other parts of the system? How are weather patterns observed, recorded, and interpreted? How does a drop of water travel through the water cycle? How does water affect our daily lives?</td>
</tr>
<tr>
<td>Fourth Grade</td>
<td>Fourth grade students study the life, earth and physical sciences based on the NJCCCS 5.1.4.A.1-A.3, 5.1.4.B.1-B.4, 5.1.4.C.1-C.3, 5.1.4.D.1-D.4, 5.2.4.A.1-A.4, 5.2.4.B.1, 5.2.4.C.1, 5.2.4.C.3, 5.2.4.C.4, 5.2.2.D.1, 5.2.4.D.1, 5.2.6.D.1, 5.2.6.E.3, 5.2.6.E.2, 5.3.2.A.1, 5.3.4.A.1, 5.3.4.A.2, 5.3.4.B.1, 5.3.2.C.1-C.3, 5.3.4.C.1, 5.3.4.C.2, 5.3.4.E.1, 5.3.4.E.2, 5.4.2.E.1, 5.4.2.G.3</td>
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<tr>
<td></td>
<td>• Ecosystems (life) ~ How do living things get energy? How do living things depend on each other and on non-living parts of the environment? What happens when part of an ecosystem is altered?</td>
</tr>
<tr>
<td></td>
<td>• Magnetism &amp; Electricity (physical) ~ How do magnets work? How does an electrical circuit (system) work? What happens if an element is removed from a circuit (system)?</td>
</tr>
<tr>
<td></td>
<td>• Matter &amp; Energy (physical) ~ How do we know that things have energy? How can energy impact the state of matter? How does light travel and behave?</td>
</tr>
<tr>
<td>Fifth Grade</td>
<td>Fifth grade students study the life, earth and physical sciences based on the NJCCCS 5.1.4.A.2, 5.1.4.a.3, 5.1.4.B.1, 5.1.4.B.3, 5.1.4.B.4, 5.1.4.C.2, 5.1.4.D.2, 5.1.4.D.3, 5.1.8.A.1, 5.1.8.A.2, 5.1.8.B.2, 5.1.8.B.3, 5.1.8.C.1, 5.1.8.C.2, 5.1.8.D.1-D.3, 5.2.4.A.1, 5.2.6.A.1, 5.2.6.A.3, 5.2.6.B.1, 5.3.4.A.3, 5.3.6.A.1</td>
</tr>
<tr>
<td></td>
<td>• Microworlds (life) ~ How do tools help extend our sense of sight? What are the properties of magnifiers? How do you know that something exists if you can’t see it?</td>
</tr>
<tr>
<td></td>
<td>• Chemistry &amp; Density (physical) ~ How do the properties of materials determine their use and identification? How might properties change after a chemical reaction? How can you change the density of an object? How do the atoms of an object effect the state of an object? What happens when two objects try to occupy the same space?</td>
</tr>
<tr>
<td></td>
<td>• Body Systems (life) ~ How does the human body work? What are choices that people can make to help their body and what are choices people can make to hurt their body?</td>
</tr>
</tbody>
</table>

**Elementary Science Curriculum**

The K-5th grade curriculum can be found in the South Brunswick School District Elementary School Science Curriculum Guide.
**Overview:**
After leaving the elementary program, students will continue their study of science at the middle school. The units of study covered at each grade level are listed below, and the accompanying curriculum matrix of standards and essential questions follows.

<table>
<thead>
<tr>
<th>Sixth Grade</th>
<th>Seventh and Eighth Grade</th>
<th>Seventh and Eighth Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems</td>
<td>A Year</td>
<td>B Year</td>
</tr>
<tr>
<td>Geology</td>
<td>Chemistry</td>
<td>Ecology</td>
</tr>
<tr>
<td>Astronomy</td>
<td>Life Systems</td>
<td>Genetics</td>
</tr>
<tr>
<td>Phylogenetics</td>
<td>Meteorology</td>
<td>Physics</td>
</tr>
</tbody>
</table>

**Middle School Matrix:**
**NJ Core Curriculum Content Standards (NJCCCS) and Essential Questions**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Standards &amp; Essential Questions by Grade Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sixth Grade</td>
<td>Sixth Grade students study the life, earth and physical sciences based on the following NJCCCS:</td>
</tr>
<tr>
<td></td>
<td>- Physical Science: 5.2.8.B.2, 5.2.6.C.1-3, 5.2.6.D.1, 5.2.8.D.1, 5.2.6.E.1, 5.2.6.E.3,</td>
</tr>
<tr>
<td></td>
<td>- Life Science: 5.3.6.A.2, 5.3.8.A.1, 5.3.6.B.1, 5.3.8.C.1</td>
</tr>
<tr>
<td></td>
<td>- Earth Science: 5.4.6.A.1-4, 5.4.8.A.1-4, 5.4.6.B.1-4, 5.4.8.B.2, 5.4.6.C.1-3,</td>
</tr>
<tr>
<td></td>
<td>5.4.8.C.1-2, 5.4.6.D.1-3, 5.4.8.D.1-3, 5.4.6.E.1</td>
</tr>
<tr>
<td></td>
<td>The Sixth Grade units of study and the related essential questions are as follows:</td>
</tr>
<tr>
<td></td>
<td>- Systems: Is every part of a system equally important? To what extent does science depend upon trial and error? Does an object at rest have as much energy as an object in motion?</td>
</tr>
<tr>
<td></td>
<td>- Geology: How long does change take? What can rocks tell us about the history of the Earth? How does technology extend human senses and understanding?</td>
</tr>
<tr>
<td></td>
<td>- Astronomy: Why is it necessary for people to study astronomy? Could life exist on another planet? Is all life on Earth affected by the Sun and Moon? Did stars enhance civilization?</td>
</tr>
<tr>
<td></td>
<td>- Phylogenetics: What does it mean to be alive? Does every living thing have a purpose? What role does classification play in everyday life? Do all organisms need the same living conditions to survive?</td>
</tr>
</tbody>
</table>
### Seventh & Eighth Grade

Seventh and eighth grade students study the life, earth and physical sciences based on the following NJCCCS:

- **Scientific Practices:** 5.1.8.A- 5.1.8.E
- **Physical Science:** 5.2.6.A.1-3, 5.2.8.A.1-7, 5.2.6.B.1, 5.2.8.B.1-2
- **Life Science:** 5.3.6.A.1-2, 5.3.8.A.1-2, 5.3.8.B.1
- **Earth Science:** 5.4.6.E.1, 5.4.8.E.1, 5.4.6.F.1, 5.4.8.F.1-3, 5.4.6.G.1, 5.4.8.G.1

The seventh and eighth grade units of study and the related essential questions are as follows:

**A Year**

- **Chemistry:** What is matter? Why is it important to classify matter? How has the study of matter affected the quality of life on Earth? What is the difference between physical and chemical properties? How are properties of matter, such as density, mass, and volume measured? What role does heat energy play in the arrangement of matter and what causes change from one state to another? How can you use the properties of matter to distinguish one substance from another? How does the Law of Conservation of Matter apply to physical and chemical changes of matter? How does the current atomic model explain the interactions of elements and the formation of compounds? How does the atomic composition of matter influence their physical properties, chemical reactivity, and use? How are elements arranged on the Periodic Table?

- **Life Systems:** What is the relationship between cells, tissues, organs, and organ systems? How are humans more complex than other organisms, with regard to specific body systems? How does the interdependence of body systems contribute to an organism’s survival? What happens when part of an organism’s internal regulation becomes faulty? How do organelles work together to meet a cell’s needs? How are multicellular organisms more or less suitable for survival?

- **Meteorology:** How does the transfer of thermal radiation influence weather conditions and/or patterns? What roles do the hydrologic cycle and ocean current patterns play in creating weather conditions? How do interactions of various weather variables contribute to the formation of weather conditions in a given time and area? What are the causes of Earth’s catastrophic weather? How can the climate of a region change over a period of time?

- **Ecology:** How do the goals of science compare and contrast with the goals of technology? How and why do catastrophic events vary? How can human activity improve the lives of generations to come? What are the challenges in obtaining and utilizing renewable resources as opposed to non-renewable? How is the world handling the demand for alternate energy? How is energy transferred among organisms in a living system? How do adaptations enable organisms to survive in their ecosystem? What are the differences between biotic and abiotic resources in an ecosystems? In what ways do biotic organisms identify their own niches? How do communities, habitats, ecosystems, niches and populations relate to one another? How do the major biomes represent the climate in relation of their geography? How do the major symbiotic relationships affect the organisms involved? How are organisms grouped in relation to the manner by which they obtain their energy? How do organisms adapt in order to survive? What are limiting factors in an ecosystem? How is evolution affected when two organisms...
<table>
<thead>
<tr>
<th>Grade</th>
<th>Standards &amp; Essential Questions by Grade Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>share the same niche? How can human activity affect us in a food chain? How can humans affect the balance of an ecosystem? Do humans have the right to alter the course of nature? Are humans a selfish species?</td>
</tr>
<tr>
<td></td>
<td><strong>Genetics:</strong> How are characteristics of an organism determined? How can mutations be both helpful and harmful? What are the fundamental building blocks of all living things? How can we predict the probability of a trait being inherited by an organism? How do scientists use genetics to affect the quality of human life? How and why are we different? How can differences in the human species affect human survival on earth? What is natural selection? How do environmental changes influence natural selection? Is extinction of a species a bad thing? How do we know that present day life forms are descended from past life?</td>
</tr>
<tr>
<td></td>
<td><strong>Physics:</strong> What effect does the Sun’s energy have on the Earth? Why is everything in the universe in motion? Why are Newton’s Laws of Motion important in describing all motion in the universe and on Earth? How do mathematical equations support scientific concepts?</td>
</tr>
</tbody>
</table>

**Curriculum**

The 6th – 8th grade curriculum can be found in the South Brunswick School District Middle School Science Curriculum Guide.
**HIGH SCHOOL SCIENCE**

**Overview:**
After leaving the middle school program, students will continue their study of science at the high school. The core units of study as well as the electives are listed below, and the accompanying curriculum matrix of standards and essential questions for the required core course follows. Because prerequisites also come into play in the high school program, these are listed as well.

**SCIENCE COURSES**

**Core Content Courses**
- Physical and Earth Science
- Physics I (A)
- Physics I (T)
- Physics I (H)
- Chemistry I (CC)
- Chemistry (T)
- Chemistry (H)
- Elements of Biology
- Biology I
- Biology I (H)

**Electives**
- Astronomy
- Biology II
- Forensic Science
- Field Ecology and Animal Behavior
- Human Anatomy and Physiology (Honors)
- Science, Technology and Society

**Advanced Placement**
- AP Biology
- AP Chemistry
- AP Environmental Science
- AP Physics B (Algebra Trigonometry based)
- AP Physics C (Calculus based)
**High School Matrix for 9-12 Core Sequence**

**Science Department Philosophy**
The science department is committed to helping all students develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment.

<table>
<thead>
<tr>
<th>Course</th>
<th>Standards and Enduring Understandings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical &amp; Earth Science</strong></td>
<td>Students study chemistry and physics based on the NJCCCS 5.1.A-D, 5.2.A-E, 5.4 (in part), 8.1 (C-F), 9.1 A, B1-2, E1, F2.</td>
</tr>
<tr>
<td></td>
<td>Models are a way to simplify our understanding of very complex ideas and phenomena. No experiment should ever be called a “failure”. All matter has some fundamental properties like mass, charge and length. Matter and energy cannot be created or destroyed. Forces play an important role in any change of motion.</td>
</tr>
<tr>
<td><strong>Biology</strong></td>
<td>Students study biology based on the NJCCCS 5.1.A-D, 5.3.A-E, 8.1 (C-F) 9.1 A, B1-2, E1, F2, F6</td>
</tr>
<tr>
<td></td>
<td>All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. Organisms are grouped in taxonomy based upon similarity. The structural and functional characteristics of an organism determine their continued survival over time under changing environmental conditions.</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td>Students study chemistry based on the NJCCCS 5.1.A-D, 5.2.A-E, 8.1 (C-F), 9.1 A, B1-2, E1, F2, F6.</td>
</tr>
<tr>
<td></td>
<td>All matter is made up of atoms in definite quantities and arrangements which determine physical and chemical properties. The periodic table is arranged based upon patterns that exist in the physical and chemical properties of elements. All changes in the properties of any substance require changes in any of the following: temperature, pressure, concentration and/or the presence of a catalyst.</td>
</tr>
<tr>
<td><strong>Physics</strong></td>
<td>Students study physics based on the NJCCCS 5.1.A-D, 5.2.B-E, 8.1 (C-F), 9.1A, B1-2, E1, F2, F6.</td>
</tr>
<tr>
<td></td>
<td>Any change in motion requires the presence of a net force. Forces play an important role in the structure and properties of matter. The total amount of mass and energy in the universe remains constant and transformations between the two can explain many natural phenomena.</td>
</tr>
</tbody>
</table>
Prerequisites

Based on the prerequisites met, students can take any of the sequences, including Honors courses. In the sequences below, Physics or PES, Chemistry and Biology are required while other courses are optional.

Sequencing

<table>
<thead>
<tr>
<th>SEQUENCE I</th>
<th>SEQUENCE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>For students who will be taking any Algebra I course in the Ninth Grade.</td>
<td>Minimum Grade of B in MS Algebra I</td>
</tr>
<tr>
<td>9  Academic Physical &amp; Earth Science (PES)</td>
<td>Physics</td>
</tr>
<tr>
<td>10 Biology [and any Science Elective-optinal]</td>
<td>Chemistry [and Biology if so chosen]</td>
</tr>
<tr>
<td>11 Physics &amp;/or Chemistry/Science Elective/AP Science</td>
<td>Biology [and science elective/AP Science if so chosen]</td>
</tr>
<tr>
<td>12 Chemistry &amp;/or Physics/Science Elective/AP Science</td>
<td>Science Elective/AP Science</td>
</tr>
</tbody>
</table>

Minimum Course Requirements

<table>
<thead>
<tr>
<th>Academic PES</th>
<th>Ninth Grade Placement, Concurrent enrollment in Algebra I (or higher).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements of Biology</td>
<td>Passing grade in PES and recommendation of science/special education teacher/case manager.</td>
</tr>
<tr>
<td>Biology I</td>
<td>Passing grade in PES, OR Completion of Physics I/Honors Physics/AP Physics B and co-enrollment in Chemistry.</td>
</tr>
<tr>
<td>Hon. Biology</td>
<td>90% (83% in Honors) in English I Academic (or higher) and one of the following: Either 90% in PES OR 83% in Chemistry (77% in Hon. Chemistry, or co-enrollment in Chemistry) and one of 80% in Physics I (77% in Honors college Physics or 77% in AP Physics B).</td>
</tr>
<tr>
<td>Chemistry I CC</td>
<td>73% in (80% in Elements) Algebra I (or higher math), Passing grade in PES.</td>
</tr>
<tr>
<td>Chemistry I T</td>
<td>83% in (93% in Elements) Algebra I OR 77% in Algebra II or 65% in Adv. Algebra II or 65% in Hon. Algebra II</td>
</tr>
<tr>
<td>Hon. Chemistry</td>
<td>Any student who has completed middle school Algebra I or Algebra I at the high school with: 87% or higher, and will complete one of Physics I with minimum 83% or Hon. Physics minimum 77% or AP Physics B with minimum 73% by the end of 9th grade OR 83% in Algebra II and one of either 90% in PES or 83% in Physics</td>
</tr>
<tr>
<td>Physics I A</td>
<td>73% in (83% in Elements) Algebra I &amp; Geometry (or higher math)</td>
</tr>
<tr>
<td>Course</td>
<td>Requirements</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Physics I T</strong></td>
<td>85% in M.S. Algebra I and placement in Advanced Geometry or higher OR 80% in Algebra I &amp; Geometry (87% in Elements).</td>
</tr>
<tr>
<td><strong>Honors (College) Physics</strong></td>
<td>87% in both Algebra I &amp; Geometry (or higher math)</td>
</tr>
<tr>
<td><strong>Astronomy</strong></td>
<td>Successful completion of two science courses</td>
</tr>
<tr>
<td><strong>Science, Technology &amp; Society</strong></td>
<td>Successful completion of two science courses</td>
</tr>
<tr>
<td><strong>Biology II</strong></td>
<td>Successful completion of Biology</td>
</tr>
<tr>
<td><strong>Forensic Science</strong></td>
<td>Successful completion of Biology and Chemistry</td>
</tr>
<tr>
<td><strong>Field Ecology &amp; Animal Behavior</strong></td>
<td>77% in (73% in Honors) Biology I and Chemistry I</td>
</tr>
<tr>
<td><strong>Human Anatomy &amp; Physiology</strong></td>
<td>80% in (77% in Honors) Biology I and Chemistry I</td>
</tr>
<tr>
<td><strong>AP Biology</strong></td>
<td>87% in (85% in Honors) Biology I, Chemistry I, Algebra II; 90% in (87% in Honors) Sophomore or Junior English</td>
</tr>
<tr>
<td><strong>AP Chemistry</strong></td>
<td>87% in (85% in Honors) Chemistry I and Physics I or completion of AP Physics AND 93% in Algebra II (or 90% in Advanced, 87% in Honors)</td>
</tr>
<tr>
<td><strong>AP Environ. Science</strong></td>
<td>83% in (80% in Honors) Biology I, Chemistry I, and Algebra II</td>
</tr>
<tr>
<td><strong>AP Physics B</strong></td>
<td><em>Rising Ninth Graders:</em> 95% in both M. S. Algebra I &amp; Geometry</td>
</tr>
<tr>
<td><strong>AP Physics C</strong></td>
<td>83% or greater in Physics IT, OR 87% or greater in Physics IA (75% in Honors) OR 75% or greater in AP Physics B and a 73% or greater in Calculus, Hon. Pre. AP Calculus, AP Calculus AB or AP Calculus BC or co-enrollment in at least Calculus.</td>
</tr>
</tbody>
</table>

**HS STEM Courses**

**Biotechnology**

**Course Description:** Biotechnology is a semester long, lab-based course designed to introduce students to the use of biological processes or organisms to manufacture products intended to improve the quality of human life. Biotechnology is a recent term that applies to ancient techniques such as brewing and selective breeding as well as to current techniques in genetic engineering. Topics include construction of recombinant DNA, genetically modified organisms, monoclonal antibodies, genetic testing, bioremediation, careers and ethics. Concepts will be introduced and reinforced with a variety of experiments, activities and demonstrations. Students will come to understand that biotechnology not only applies to their daily lives but will be important to them in their future.

Grades will be based on activities, presentations, laboratory reports, homework quizzes and exams. There will be a comprehensive final exam at the end of the semester. Students will be required to upload some assignments to sites such as turnitin, edmodo and our class wiki.
Overview of Engineering

Description:
Overview of Engineering is a college-prep course for juniors and seniors who have an interest in majoring in engineering at a four-year college or university. This project-based learning course extends prior work in math, physics, and chemistry and applies it to engineering design problems and processes. Multiple areas will be explored including, but not limited to, the traditional disciplines of chemical, civil, electrical, and mechanical engineering. Additional design topics include cost analysis, ethics, and communications (oral and written). The course will assist students in making decisions on a prospective major as well as discussions on post-graduate opportunities in the work force and graduate education.

Curriculum

The 9th - 12th grade curriculum can be found in the South Brunswick School District High School Science Curriculum Guide.
Academic Physical & Earth Science

Course Overview:
All SBHS, science students will develop good questioning skills to become critical & scientific thinkers in a safe and caring environment in alignment with the New Jersey Core Content Standards for science.

Physical and Earth Science is a skill-based, laboratory-centered course designed to introduce the 9th grade high school student to foundational topics in physical science. Students will carry out experiments and activities in order to understand the world around them better and to develop good scientific thinking skills. Students will use a variety of strategies to learn about concepts such as structure of matter, changes in matter, motion, forces, energy, electricity, and magnetism.

Students' grades are based upon a variety of assessments including activities, presentations, laboratory work, reports, homework, tests, and quizzes. Physical and Earth Science meets the requirements of colleges and universities as a lab science course. This course is a prerequisite for many of the upper level science courses.

Philosophy Statement:
Physical and Earth Science is designed to give students a broad background in science in order to produce scientifically literate citizens. In today's society both scientific knowledge and technology are growing at a rapid pace. This course aims to provide a foundation on which students can build scientific understanding. Students will develop good questioning skills to become critical & scientific thinkers in a safe and caring environment in alignment with the New Jersey Core Content Standards for science.

Textbook: *Science Spectrum, Physical Approach, Holt*
## NJCCCS 2009 Standards:

**5.1.12.A.1** Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.

**5.1.12.A.2** Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.

**5.1.12.A.3** Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

**5.1.12.B.1** Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.

**5.1.12.B.2** Mathematical tools and technology are used to gather, analyze, and communicate results.

**5.1.12.B.3** Empirical evidence is used to construct and defend arguments.

**5.1.12.B.4** Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

**5.1.12.C.1** Refinement of understandings, explanations, and models occurs as new evidence is incorporated.

**5.1.12.C.2** Data and refined models are used to revise predictions and explanations.

**5.1.12.C.3** Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.

**5.1.12.D.1** Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.

**5.1.12.D.2** Science involves using language, both oral and written, as a tool for making thinking public.

**5.1.12.D.3** Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.

### Table

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>Enduring Understandings &amp; Essential Questions</th>
<th>Skills &amp; Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Science</td>
<td>EU: Scientific investigation involves asking scientifically-oriented questions, collecting evidence, forming experiment and explanations, connecting</td>
<td>Describe the main branches of natural science and relate them to each other. Describe the relationship between science and technology. Distinguish among facts, theories, and laws. Explain the roles of models and mathematics in scientific theories and laws. Use critical thinking skills to solve problems. Describe the steps of the scientific</td>
</tr>
<tr>
<td>Chapter</td>
<td>Topics</td>
<td>Enduring Understandings &amp; Essential Questions</td>
<td>Skills &amp; Objectives</td>
</tr>
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<td>---------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>explanations to scientific knowledge, and communicating and justifying explanations.</td>
<td>method. Use some of the tools scientists use to investigate nature. Explain the objective of a consistent system of units, and identify the SI units for length, mass, and time. Identify what each common SI prefix represents, and convert measurements. Interpret line graphs, bar graphs, and pie graphs. Use scientific notation in problem solving. Explain the difference between precision and accuracy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>EQ:</strong> How do we gather information about our world? What skills are needed to perform scientific experiments?</td>
<td></td>
</tr>
</tbody>
</table>

**NJCCCS 2009 Standards:**

**5.2.12.C.2** Heating increases the energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a pure solid increases the vibrational energy of its atoms, molecules, or ions. When the vibrational energy of the molecules of a pure substance becomes great enough, the solid melts.

| 10 | Temperature | **EU:** Temperature is the measurement of heat energy. **EQ:** What is temperature and how is it measured? | **Define** temperature. **Convert** temperature readings between the Fahrenheit, Celsius, and Kelvin scales. **Describe** heat as a form of energy transfer. |

**NJCCCS 2009 Standards:**

**5.2.12.A.1** Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons. **5.2.12.A.2** Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.
Gas particles move independently and are far apart relative to each other. The behavior of gases can be explained by the kinetic molecular theory. The kinetic molecular theory can be used to explain the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample.

There is a natural tendency for a system to move in the direction of disorder or entropy.

Heating increases the energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic energy of the atoms, molecules, or ions increases, the temperature of the matter increases.

Heating a pure solid increases the vibrational energy of its atoms, molecules, or ions. When the vibrational energy of the molecules of a pure substance becomes great enough, the solid melts.

Matter
- What is matter?
- Matter and energy
- Properties of matter

EU: All objects and substances in the natural world are composed of matter. Matter has two fundamental properties.

EQ: What are the different states of matter? How does energy determine the state of matter?

Explain the relationship between matter, atoms, and elements.
Distinguish between elements and compounds.
Interpret and write some common chemical formulas.
Categorize materials as pure substances or mixtures.
Use the kinetic theory to describe the properties and structures of the different states of matter.
Describe the energy transfers involved in changes of state.
Describe the law of conservation of mass energy and explain how it applies to changes of state.
Distinguish between chemical and physical properties of matter.
Perform calculations involving density.
Distinguish between chemical and physical changes in matter.
Apply the law of conservation of mass and energy to chemical and physical changes.

NJCCCS 2009 Standards:
5.2.12.A.1 Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.

5.2.12.A.2 Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.
### Chapter 5.2.12.A.3

In the Periodic Table, elements are arranged according to the number of protons (the atomic number). This organization illustrates commonality and patterns of physical and chemical properties among the elements.

### Chapter 5.2.12.A.4

In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.

### Chapter 5.2.12.B.1

An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>Enduring Understandings &amp; Essential Questions</th>
<th>Skills &amp; Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Atoms and the Periodic Table of Elements</td>
<td>EU: The atomic structures of materials determine their properties and their placement on the Periodic Table of Elements.</td>
<td>Explain Dalton’s atomic theory and describe why it was more successful than Democritus’s theory. State the charge, mass, and location of each part of an atom according to the modern model of the atom. Compare and contrast Bohr’s model with the modern model of the atom. Relate the organization of the periodic table to the arrangement of electrons within an atom. Explain why some atoms gain or lose electrons to form ions. Determine how many protons, neutrons, and electrons an isotope has, given its symbol, atomic number, and mass number. Describe how the abundance of isotopes affects an element’s average atomic mass. Locate alkali metals, alkaline-earth metals, and transition metals in the periodic table. Locate semiconductors, halogens, and noble gases in the periodic table. Relate an element’s chemical properties to the electron arrangement of its atoms. Explain the relationship between a mole of a substance and Avogadro’s constant.</td>
</tr>
<tr>
<td></td>
<td>• Atomic structure</td>
<td>EQ: What is the structure of an atom? What gives matter its physical properties? How can we use the properties of elements to categorize them? What is the periodic table and how is it used?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Periodic table</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Families of elements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NJCSCS 2009 Standards:**

5.2.12.B.1 An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.
### Enduring Understandings & Essential Questions

**5.2.12.B.2** A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>Skills &amp; Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The Structure of Matter</td>
<td><strong>EU:</strong> The atomic structures of substances determine their properties and bonding affinities.</td>
</tr>
<tr>
<td></td>
<td>• Compounds and molecules</td>
<td><strong>Distinguish</strong> between compounds and mixtures.</td>
</tr>
<tr>
<td></td>
<td>• Ionic and covalent bonding</td>
<td><strong>Relate</strong> the chemical formula of a compound to the relative numbers of atoms or ions present in the compound.</td>
</tr>
<tr>
<td></td>
<td>• Compound names and formulas</td>
<td><strong>Use</strong> models to visualize a compound’s chemical structure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Describe</strong> how the chemical structure of a compound affects its properties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Explain</strong> why atoms sometimes join to form bonds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Explain</strong> why some atoms transfer their valence electrons to form ionic bonds, while other atoms share</td>
</tr>
<tr>
<td></td>
<td></td>
<td>valence electrons to form covalent bonds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Differentiate</strong> between ionic, covalent, and metallic bonds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Compare</strong> the properties of substances with different types of bonds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Name</strong> simple ionic and covalent compounds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Write</strong> chemical formulas for simple ionic and covalent compounds.</td>
</tr>
</tbody>
</table>

**NJCCCS 2009 Standards:**

5.2.12.B.1 An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.

5.2.12.B.2 A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.

5.2.12.B.3 The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept.

5.2.12.D.2 The driving forces of chemical reactions are energy and entropy. Chemical reactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).

5.2.12.D.4 Energy may be transferred from one object to another during collisions.

5.2.12.D.5 Chemical equilibrium is a dynamic process that is significant in many systems, including biological, ecological, environmental, and geological systems. Chemical reactions
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>Enduring Understandings &amp; Essential Questions</th>
<th>Skills &amp; Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>occur at different rates. Factors such as temperature, mixing, concentration, particle size, and surface area affect the rates of chemical reactions.</td>
<td></td>
</tr>
</tbody>
</table>
| 5       | Chemical Reactions  
- The nature of chemical reactions  
- Reaction types  
- Balancing chemical equations | EU: Elements and compounds can react to form new substances and each reaction involves the flow of energy.  
EQ: What determines the type and extent of a chemical reaction? What are the five most common chemical reactions and how are they balanced? | Recognize some signs that a chemical reaction is taking place.  
Explain chemical changes in terms of the structure and motion of atoms and molecules.  
Describe the differences between endothermic and exothermic reactions.  
Identify situations involving chemical energy.  
Distinguish among five general types of chemical reactions.  
Predict the products of some reactions based on the reaction type.  
Demonstrate how to balance chemical equations. |

**NJCCCS 2009 Standards:**  
5.2.12.A.6 Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.

| 6       | Acids, Bases, and pH | EU: Substances can be characterized and compared by their pH.  
EQ: What is the meaning of pH? How is pH measured? | Compare and contrast acids and bases.  
Relate the pH of a solution to the concentration and strength of a dissolved acid or base.  
Recognize several acidic and basic substances commonly found in homes.  
Describe the acidic or basic characteristics of household items. |

**NJCCCS 2009 Standards:**  
5.2.12.E.1 The motion of an object can be described by its position and velocity as functions of
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
<th>Enduring Understandings &amp; Essential Questions</th>
<th>Skills &amp; Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Motion and Forces</td>
<td>EU: It takes energy (forces) to change the motion of objects. The same basic rules govern the motion of all bodies of matter. EQ: How do Newton’s Laws explain the nature of physics? How can physics be used to describe and predict motion?</td>
<td>Relate speed to distance and time. Distinguish between speed and velocity. Recognize that all moving objects have momentum. Solve problems involving time, distance, velocity, and momentum. Calculate the acceleration of an object. Describe how force affects the motion of an object. Distinguish between balanced and unbalanced forces. Explain how friction affects the motion of an object. State Newton’s three laws of motion, and apply them to physical situations. Calculate force, mass, and acceleration with Newton’s second law. Recognize that the free-fall acceleration near Earth’s surface is independent of the mass of the falling object. Explain the difference between mass and weight. Identify paired forces on interacting objects.</td>
</tr>
<tr>
<td>9</td>
<td>Work and Energy</td>
<td>EU: Energy takes many forms but is</td>
<td>Define work and power. Calculate the work done on an object and the rate at which work is done.</td>
</tr>
</tbody>
</table>

**NJCCCS 2009 Standards:**
5.2.12.D.1 The potential energy of an object on Earth’s surface is increased when the object’s position is changed from one closer to Earth’s surface to one farther from Earth’s surface.
5.2.12.D.4 Energy may be transferred from one object to another during collisions.
<table>
<thead>
<tr>
<th>Chapter</th>
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<th>Skills &amp; Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Conservation of energy</td>
<td>never created nor destroyed. Energy forms are associated with the motion of mass (kinetic energy), and the position of mass and with energy fields (potential energy). <strong>EQ:</strong> How does energy change form? What does it mean to say that energy is conserved?</td>
<td><strong>Explain</strong> the relationship between energy and work. <strong>Define</strong> potential energy and kinetic energy. <strong>Calculate</strong> kinetic energy and gravitational potential energy. <strong>Distinguish</strong> between mechanical and nonmechanical energy. <strong>Identify</strong> nonmechanical forms of energy. <strong>Identify</strong> and <strong>describe</strong> transformations of energy. <strong>Explain</strong> the law of conservation of energy. <strong>Explain</strong> where energy goes when it seems to disappear.</td>
</tr>
</tbody>
</table>

**NJCCCS 2009 Standards:**

**5.2 Physical Science:** All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

**C. Forms of Energy:** Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

**D. Energy Transfer and Conservation:** The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

| 11 | Waves | EU: Waves transfer energy. Mechanical and electromagnetic waves have many natural and technological uses. **EQ:** How do frequency and wavelength affect wave speed? | **Recognize** that waves transfer energy. **Distinguish** between mechanical waves and electromagnetic waves. **Explain** the relationship between particle vibration and wave motion. **Distinguish** between transverse waves and longitudinal waves. **Identify** the crest, trough, amplitude, and wavelength of a wave. **Define** the terms frequency and period. **Solve** problems involving wave speed, frequency, and wavelength. **Describe** the Doppler effect. |

| 31 |
### NJCCCS 2009 Standards:

**5.2 Physical Science:** All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

- **C. Forms of Energy:** Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.
- **D. Energy Transfer and Conservation:** The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

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<tr>
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<tr>
<td>12</td>
<td>Sound and Light</td>
<td>EU: Energy is transferred through sound and light.</td>
<td>Recognize what factors affect the speed of sound.</td>
</tr>
<tr>
<td></td>
<td>- Sound</td>
<td></td>
<td>Relate loudness and pitch to properties of sound waves.</td>
</tr>
<tr>
<td></td>
<td>- The nature of light</td>
<td>EQ: How is energy transferred through sound and light?</td>
<td>Explain how harmonics and resonance affect the sound from musical instruments.</td>
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<td>Describe the function of the ear.</td>
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<td>Explain how sonar and ultrasound imaging work.</td>
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<td>Recognize that light has both wave and particle characteristics.</td>
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<td>Relate the energy of light to the frequency of electromagnetic waves.</td>
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<td>Describe different parts of the electromagnetic spectrum.</td>
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<td></td>
<td>Explain how electromagnetic waves are used in communication, medicine, and other areas.</td>
</tr>
<tr>
<td>13/14</td>
<td>Electricity and Magnetism</td>
<td>EU: Electric fields provide the force that moves charged</td>
<td>Indicate which pairs of charges will repel and which will attract.</td>
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<td></td>
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<td></td>
<td>Explain what factors affect the strength of the electric force.</td>
</tr>
<tr>
<td>Chapter</td>
<td>Topics</td>
<td>Enduring Understandings &amp; Essential Questions</td>
<td>Skills &amp; Objectives</td>
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<tr>
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<td>particles. Magnetic fields are produced around moving charges.</td>
<td><strong>Describe</strong> the characteristics of the electric field due to a charge. <strong>Recognize</strong> that like magnetic poles repel and unlike poles attract. <strong>Describe</strong> the magnetic field around a permanent magnet. <strong>Explain</strong> how compasses work. <strong>Describe</strong> the orientation of Earth’s magnetic field.</td>
</tr>
</tbody>
</table>

**EQ:** What is an electrical current? What is electrical safety? How does a magnet work?
Sequencing & Pacing Syllabus

The following document is a collection of the concepts that are to be covered in Academic Physical and Earth Science. This is to be used in conjunction with Holt Science Spectrum text.

(Each section should have a lab, demonstration, or activity component.)

Chapter 1 Introduction to Science
- 1.1-1.3 shall be integrated within lessons of following chapters.

Unit 1 The Nature of Matter

Chapter 2 - Matter (10 blocks)
- 2.1: What is matter?
  - All key terms, objectives, and critical thinking questions
- 2.2: Matter and energy
  - All key terms, objectives, and critical thinking questions
    - Include phase change graph page 49
    - 10.1: Temperature
      - All key terms and objectives
    - LAB (baseline) – Law of Conservation of Mass
      - Include scientific method (1.2)
      - Include Law of conservation of energy (2.2)
      - Include accuracy and precision (1.3)
      - Include significant figures: stress that they depend on experiment done.
- 2.3: Properties of Matter
  - All key terms, objectives, and critical thinking questions
    - Density
      - Introduce conversion of units (1.2)
      - LAB ACTIVITY
      - All practice problems

Chapter 3 - Atoms and the Periodic Table (10 blocks)
- 3.1: Atomic Structure
  - Discovery is suggested: Indirect means for discovering what we cannot "see."
    - ACTIVITY: Demonstrating how in science, we use models to predict/hypothesize/demonstrate things we cannot "see."
  - All key terms, objectives, and critical thinking questions
    - Bohr Model vs Modern Model
      - History behind models is optional
- 3.2: A Guided Tour of the Periodic Table
  - Key terms, objectives, and critical thinking questions excluding orbitals.
    - Isotopes: Why are they weighted averages?
- 3.3: Families of Elements
  - All key terms, objectives, and critical thinking questions
  - LAB ACTIVITY: to connect periodic table organization to elements.
  - ACTIVITY (Strongly recommended or activity of equal challenge): Alien Periodic Table from page 104 in Prentice Hall Physical Science.
- 3.4 Using Moles to Count Atoms
Chapter 4 - The Structure of Matter (10 blocks)

- 4.1: Compounds and Molecules
  - Key terms, objectives, and critical thinking questions excluding bond length, bond angle, and network structures vs molecular compounds.
    - Focus on chemical bonds not being physical but attractions between atoms.

- 4.2: Ionic and Covalent Bonding
  - All key terms, objectives, and critical thinking questions
    - Polyatomic ions: common ions chart, students should be familiar with ion formula/name and should be able to identify them when naming compounds.
  - LAB ACTIVITY: Salt and Sugar Melting Lab to show the differences in ionic and covalent bonds.

- 4.3: Compound Names and Formulas
  - All key terms, objectives, and critical thinking questions
    - Optional: Empirical vs molecular formula

- 4.4: Organic and Biochemical Compounds
  - Emphasize organic vs inorganic
    - Organic is what is found in biochemical compounds
    - HONC
    - Polymers

Unit 2 Changes in Matter

Chapter 5 - Chemical Reactions (10 blocks)

- 5.1: The Nature of Chemical Reactions
  - All key terms, objectives, and critical thinking questions
  - LAB showing evidence of chemical change
    - Suggestion: stations for signs of a chemical reaction

- 5.2: Reaction Types
  - Key terms, objectives, and critical thinking questions excluding REDOX.

- 5.3: Balancing Chemical Equations
  - All key terms, objectives, and critical thinking questions

- 5.4: Rates of Change
  - Equilibrium
    - What is it?
    - Why is it necessary?
    - How it relates to the Laws of Conservation of Mass and Energy
  - Factors that affect reaction rates
  - Catalysts/Enzymes
    - What are they? What is their role in a chemical reaction?

Chapter 6 - Solutions, Acids, and Bases (3 blocks)

- 6.3: Acids, Bases, and pH
  - pH scale
  - Common characteristics of acids and bases
  - Indicators
    - What are they? What are examples other than Litmus paper
  - LAB/ACTIVITY: Suggested “Acids & Bases in the Home”
Unit 3 Motion and Energy

Chapter 8 - Motion and Forces (10 blocks)
- 8.1: Motion
  - All key terms, objectives, and critical thinking questions
    - Introduce vectors
    - Organizing data and graphing (1.3)
    - Relationships between d/t, v/t graphs with emphasis on slope meaning.
    - Unit conversions and Significant figures (Chapter 1)
    - Simple law of conservation of momentum problems
  - LAB ACTIVITY
- 8.2: Acceleration and Force
  - All key terms, objectives, and critical thinking questions
    - Draw simple free body diagrams. Include one dimensional problem solving
  - LAB ACTIVITY
- 8.3: Newton's Laws of Motion
  - All key terms, objectives, and critical thinking questions
    - Emphasize difference between weight and mass.
  - LAB ACTIVITY

Chapter 9 - Work and Energy (8 blocks)
- 9.1: Work and Power
  - Key terms, objectives, and critical thinking questions excluding mechanical advantage.
    - Introduce scientific notation (1.3)
  - LAB ACTIVITY
- 9.3: What is Energy?
  - All key terms, objectives, and critical thinking questions
    - Energy transfer (10.2)
  - LAB ACTIVITY suggested
- 9.4: Conservation of Energy
  - Key terms, objectives, and critical thinking questions excluding efficiency calculations.
  - LAB ACTIVITY

Chapter 10 - Heat and Temperature
Included in Chapters 2 and 9

Unit 4 Waves and Wave Properties

Chapter 11 - Waves & Chapter 12 - Sound and Light (7 blocks)
Chapters 11 and 12 are to be combined.

- 11.1: Types of Waves
  - Emphasize that particles of the medium do not move, rather energy does move and the particles vibrate.
  - Differences between mechanical and electromagnetic waves.
- Relate transverse waves to electromagnetic waves and longitudinal waves to sound waves.
- Electromagnetic spectrum and the fact that the visible light spectrum makes up a small part of the entire EM spectrum.

- 11.2: Characteristics of Waves
  - All key terms, objectives, and critical thinking questions
    - Emphasize speed of the wave depends on the medium. Explain the differences between speed of sound and light. (portions of 12.1 and 12.2)

- Properties of waves (combination of sound and light)
  - Reflection of sound and light (12.3)
  - Refraction of sound and light (11.3: page 376; 12.4: pages 412-413)
  - Doppler Effect for sound and light (11.2)

**Unit 5 Electricity and Magnetism**

**Chapter 13 - Electricity (2 blocks)**
- Explain origin of current related to ions, like and unlike charges attract/repel. Conductor and insulators (refer back to periodic table).
- Simple circuit. No calculations.

**Chapter 14 - Magnetism (2 blocks)**
- Like magnetic poles repel and unlike magnetic poles attract.
- Magnets are sources of magnetic fields
  - Demonstrate magnetic fields. Students should be able to draw magnetic field.
- Electric currents have a magnetic field around them
  - DEMONSTRATION
Physics I

Course Overview:

We offer two versions of Physics I in the High School.

Physics I (A) - Active Physics I or Theme-based Physics
This version of Physics I places focus on the influence of physics on our lives. It is designed around relevant themes and projects. This is a change from the usual organization around content topics. It is designed for students planning careers not related to science. The units of study are: sports, home, medicine, predictions, transportation, and communication.

Physics I (T) - Traditional Physics I
This version of Physics I places focus on physics content and theory. It is designed for students planning careers related to science. The main topics included are: motion, forces, work and energy, momentum, gravity, electrostatics, simple circuits, magnetism, and waves. Algebra, trigonometry, and graphical analysis are mathematical tools used in this course.

Regardless of which course a student chooses, both courses include the same content, and the skills and objectives that students will master remain the same too. All SBHS students will develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment in alignment with New Jersey Core Content Standards for Science.
**Philosophy:**
Students will be expected to work independently, cooperatively, and at times, competitively. Students are assigned homework frequently. Students will also do project work throughout the year. Students' grades are based upon class assignments, class activities, presentations, laboratory work, laboratory reports, homework, tests, quizzes and a variety of other assessments. Some of the laboratories are designed to demonstrate or illustrate concepts, while others are inquiry-based and involve open-ended experimentation.

**Textbook:** Physics I (A/T) - Conceptual Physics, by Hewitt, Pearson/SFAW

**New Jersey Science Standards:**
The following standards have been covered in this curriculum:

<table>
<thead>
<tr>
<th>Standard 1</th>
<th>Standard 2</th>
<th>Standard 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2.4.A.4</td>
<td>5.2.8.C.2</td>
<td>5.2.12.D.1m 4</td>
</tr>
<tr>
<td>5.2.8.A.3</td>
<td>5.2.4.D.1</td>
<td>5.2.12.E.1, 2, 3</td>
</tr>
<tr>
<td>5.2.12.A.1, 2, 4</td>
<td>5.2.6.D.1</td>
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</tr>
<tr>
<td>5.2.6.C.1, 2</td>
<td>5.2.8.D.1</td>
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</tr>
</tbody>
</table>

**Topic: Introduction to Physics, Measurement, and Units**

**Standards**
5.2 Strand E

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

**Enduring Understandings**
- People need a common language if we expect to communicate with each other.
- Words often have one meaning in everyday language and another, more specific meaning, in science.
- Models are a way to simplify our understanding of something that is too extreme to be studied under normal conditions.
- No experiment can ever be called a failure.
- The laws and theories of science are not “written in stone.”

**Essential Questions**
- How does math relate to science?
- What constitutes a failed experiment?
- When do we use science in our everyday lives?
- Why do we need units?
- Is it acceptable to change a scientific law or theory?

**Skills and Objectives**
Students will be able to:
- Manipulate units in combinations (6 m x 7 m = 42 m²)
- Estimate distances in metric units
- Define and note differences among fact, theory, and law
- Define and note differences between hypothesis and opinion
- Define and note differences between precision and accuracy

**Topic: Linear Motion**

**Standards**
5.2 Strand E
The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

<table>
<thead>
<tr>
<th><strong>Enduring Understandings</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• An understanding of the concepts of motion broadens everyone’s lives.</td>
</tr>
<tr>
<td>• Words often have one meaning in everyday language and another, more specific meaning, in science.</td>
</tr>
<tr>
<td>• Motion can be depicted visually, most usefully through graphs.</td>
</tr>
<tr>
<td>• The slope and shape of a graph have meaning.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Essential Questions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• How do the concepts of motion figure in to our everyday life?</td>
</tr>
<tr>
<td>• What accelerates?</td>
</tr>
<tr>
<td>• When is an object accelerating?</td>
</tr>
<tr>
<td>• What is the difference between velocity and acceleration?</td>
</tr>
<tr>
<td>• Why do we need to be able to convert units?</td>
</tr>
<tr>
<td>• How can we visually represent motion?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Skills and Objectives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will know and be able to:</td>
</tr>
<tr>
<td>• Define time, distance, average speed, average velocity, acceleration, displacement, instantaneous speeds and velocities, vector, and scalar</td>
</tr>
<tr>
<td>• Use and manipulate equations: $v_{\text{avg}} = \frac{d}{t}$ ; $a = \frac{\Delta v}{\Delta t}$ ; $v_{\text{avg}} = \frac{(v_0 + v_f)}{2}$ ; $d = v_0t + \frac{1}{2}at^2$</td>
</tr>
<tr>
<td>• Manipulate units of speed and acceleration: [m/s] and [m/s$^2$]</td>
</tr>
<tr>
<td>• Do unit conversions</td>
</tr>
<tr>
<td>• Identify the three ways to change velocity or to accelerate</td>
</tr>
<tr>
<td>• Plot data for constant velocity and accelerated motion</td>
</tr>
<tr>
<td>• Analyze graphs of motion – calculating slope, telling a story of an object’s motion</td>
</tr>
</tbody>
</table>

**Topic: Free Fall**

**Standards**
5.2 Strand E

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

The motion of an object changes only when a net force is applied.

<table>
<thead>
<tr>
<th><strong>Enduring Understandings</strong></th>
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<tbody>
<tr>
<td>• Words often have one meaning in everyday language and another, more specific meaning, in science.</td>
</tr>
<tr>
<td>• The slope and shape of a graph have meaning.</td>
</tr>
<tr>
<td>• All objects in free fall experience the same acceleration.</td>
</tr>
<tr>
<td>• Velocity is motion, and acceleration is how motion changes.</td>
</tr>
<tr>
<td>• Free fall motion is symmetric about the midpoint.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Essential Questions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• What does it mean for an object to be in free fall?</td>
</tr>
<tr>
<td>• What is the difference between velocity and acceleration?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Skills and Objectives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will know and be able to:</td>
</tr>
<tr>
<td>• Define air resistance, vacuum, and free fall</td>
</tr>
<tr>
<td>• Identify various ways to set an object into free fall motion</td>
</tr>
</tbody>
</table>
- Apply equations learned in Linear Motion to the specific case of free fall
- Graph velocity vs. time and distance vs. time graphs for free fall motion
- Link equations (linear and quadratic) to the shapes of the graphs they produce
- Identify the importance of setting a positive direction when dealing with vectors that point in opposite directions
- Analyze graphs of motion – calculating slope

**Topic: Vectors and Newton's Laws**

**Standards**
5.2 Strand E
The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.
The motion of an object changes only when a net force is applied.
The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship \(a=\frac{F_{\text{net}}}{m}\) is independent of the nature of the force.

**Enduring Understandings**
- Words often have one meaning in everyday language and another, more specific meaning, in science.
- Vector addition is commutative.
- An object’s motion in one dimension can be treated independently of its motion in other dimensions.
- The slope and shape of a graph have meaning.
- An understanding of inertia, mass, and force broaden our everyday lives.
- Newton’s three Laws of Motion:
  1) An object tends to maintain its current state of motion unless acted upon by an outside force.
  2) The net force on an object determines its acceleration.
  3) For every action, there is an equal and opposite reaction. (Forces come in equal and opposite pairs that occur at the same time.)
- The motion of any object can be described as either equilibrium or not equilibrium.
- Friction is always present (we do not live in a perfect world).

**Essential Questions**
- How do vector quantities combine?
- What accelerates?
- What causes an object to accelerate?
- How do the concepts of inertia, mass, and force affect our daily lives?
- What is the difference between mass and weight?
- What are the consequences of being in equilibrium? Of not being in equilibrium?

**Skills and Objectives**
Students will know and be able to:
- Define of resultant and components
- Find the magnitude and direction of the resultant of adding vectors
- Use and manipulate the basic trigonometric functions (sine, cosine, and tangent) and their corresponding inverse functions
- Resolve a vector into two components
- Define force, inertia, weight, and mass
- Use and manipulate equations for force: \(F_{\text{net}} = ma\) \(w = mg\)
- Manipulate units of force: \([\text{kg}\cdot\text{m/s}^2] = \text{[N]}\)
- Construct and analyze free-body diagrams building up equations of net force
- Know that friction always acts against the direction of motion
- Analyze graphs of motion – calculating slope

**Topic: Impulse and Momentum**

**Standards**
5.2 Strand D
Energy may be transferred from one object to another during collisions.
5.2 Strand E
The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.
The motion of an object changes only when a net force is applied.
The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship \(a=\frac{F_{\text{net}}}{m}\) is independent of the nature of the force.

**Enduring Understandings**
- Law of Conservation of Momentum: The vector sum of all momenta in a closed system is conserved.

**Essential Questions**
- What is the advantage to using impulse and momentum techniques to solve a problem, as opposed to using Newton’s Laws?

**Skills and Objectives**
Students will be able to:
- Define impulse, momentum, conserved, closed system
- Use and manipulate relevant equations: \(J = Ft\) \quad \(J_{\text{net}} = F_{\text{net}}t\) \quad \(J_{\text{net}} = \Delta p\) \quad \(p = mv\)
- Manipulate units of impulse and momentum: \([\text{N}\cdot\text{s}] = [\text{kg}\cdot\text{m/s}]\)
- Apply vector addition to impulse and momentum problems with a single object
- Identify the momentum in a closed system before and after an interaction between two objects
- Understand the importance of setting a positive direction when dealing with vectors that point in opposite directions
- Apply the Law of Conservation of Momentum to analyze two-object systems

**Topic: Projectile Motion**

**Standards**
5.2 Strand E
The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.
The motion of an object changes only when a net force is applied.
The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship \(a=\frac{F_{\text{net}}}{m}\) is independent of the nature of the force.

**Enduring Understandings**
- The slope and shape of a graph have meaning.
- An object’s motion in one dimension can be treated independently of its motion in other dimensions.
- All objects in free fall experience the same acceleration.
- Velocity is motion, and acceleration is how motion changes.
- Free fall motion is symmetric about the midpoint.
Essential Questions

- What does it mean for an object to be in free fall?
- What are the advantages to treating projectile motion as independent 1-dimensional motions?
- What is the difference between velocity and acceleration?

Skills and Objectives

Stunts will be able to:

- Use definitions of projectile, trajectory, and range
- Resolve vectors into components and finding resultant velocities from components
- Apply equations learned in Linear Motion, Free Fall, and Vectors and Newton’s Laws to the specific case of 2-dimensional projectile motion
- Graph velocity vs. time and distance vs. time graphs for free fall motion
- Link equations (linear and quadratic) to the shapes of the graphs they produce
- Identify the importance of setting a positive direction when dealing with vectors that point in opposite directions
- Analyze graphs of motion – calculating slope
- Understand the relationship between range and angle; discovering that 45° gets the maximum range for a projectile

Topic: Work and Energy

Standards

5.2 Strand D

When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. As an object falls, its potential energy decreases as its speed, and consequently its kinetic energy, increases. While an object is falling, some of the object’s kinetic energy is transferred to the medium through which it falls, setting the medium into motion and heating it.

The potential energy of an object on Earth’s surface is increased when the object’s position is changed from one closer to Earth’s surface to one farther from Earth’s surface. Energy may be transferred from one object to another during collisions.

5.2 Strand E

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

The motion of an object changes only when a net force is applied.

The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship \( a = \frac{F_{\text{net}}}{m} \) is independent of the nature of the force.

Enduring Understandings

- Words often have one meaning in everyday language and another, more specific meaning, in science.
- Law of Conservation of Energy:
  - In general, energy cannot be created or destroyed – only transferred from one object to another or changed from one form to another.
  - Mechanical energy is conserved when gravity (a conservative force) drives the system and friction is eliminated.
- Work done by, or against, gravity (or any conservative force) is path-independent.
- Objects have potential energy when they are in position or location that they do not “want to be.”
- Friction is always present (we do not live in a perfect world).
### Essential Questions
- How do the concepts of work, energy, and power affect our daily lives?
- When is work done?
- What is the difference between work and power?
- How can we use the conservation of mechanical energy to our advantage?
- When is mechanical energy conserved and when is it not?

### Skills and Objectives
Students will be able to:
- Define work, kinetic energy, potential energy, mechanical energy, power
- Use and manipulate equations for work, energy, and power: 
  
  \[
  W = Fd \quad KE = \frac{1}{2}mv^2 \\
  PE = mgh \quad P = \frac{W}{t}
  \]
- Manipulate units of work, energy, and power: 
  \[
  \text{[kg}\cdot\text{m}^2/\text{s}^2] = \text{[N}\cdot\text{m}] = \text{[J]} \quad \text{[J]/s} = \text{[W]}
  \]
- Analyze pictures of motion to determine if (+), (-), or no work is done
- Use conservation of mechanical energy to solve mechanics problems

Students will know:
- That besides mechanical energy (kinetic and potential), there are the non-mechanical forms of energy which impact our daily lives

### Topic: Circular Motion and Universal Gravitation

#### Standards
5.2 Strand E
The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

Objects undergo different kinds of motion (translational, rotational, and vibrational).
The motion of an object changes only when a net force is applied.
The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship (\(a=\frac{F_{\text{net}}}{m}\)) is independent of the nature of the force.

#### Enduring Understandings
- Circular motion can be observed in all facets of nature; the properties we study in the classroom can be applied to all scales, from the smallest (atoms) to the largest (planets and stars).
- Law of Universal Gravitation: All objects attract all other objects with a force that depends on their masses and the distance of separation.
- Objects create gravitational fields; other objects interact with those fields.
- Gravity, though experienced every day in a very basic manner, is still not fully understood in terms of how it relates to the other fundamental interactions.

#### Essential Questions
- What goes in circles?
- Is normal force always equal to weight?
- If we seem to feel centrifugal force, why is it called a fake force?
- If all objects are attracted to all other objects, why do we not always feel those attractive forces?

#### Skills and Objectives
Students will know:
- Definitions of tangential speed, period, uniform circular motion, centripetal (acceleration and force), field, gravitational field
Isaac Newton invented calculus to solve the problem of linking earth-bound studies of gravity with the motion of heavenly bodies; in doing so, he developed the law of universal gravitation.

Fields are ways for us to describe how an object can influence the motion of other objects without contact.

The gravitational field of an object drops off quickly with distance.

The equations for $f$ and $g$ only work outside the objects; inside a spherically symmetric body of uniform density, for example, $g$ varies linearly with distance from the center.

Albert Einstein suggested a totally different view of gravity – that all objects bend the fabric of space-time in their vicinity; this view agrees with Newton’s view, mathematically.

Students will be able to:

- Have clearly understanding that centripetal force is not a new kind of force; rather, it is another name for net force in circular motion.
- Draw free-body diagrams to analyze how forces must combine to create circular motion.
- Investigate the consequences of traveling in a vertical circle at speeds above or below the minimum or maximum speeds to continue in circular motion (depending on the situation).
- Use and manipulate equations: $v = \frac{2\pi r}{T}$, $a_c = \frac{v^2}{r}$, $F_c = F_{net} = \frac{mv^2}{r}$,

\[
F_g = \frac{Gm_1m_2}{r^2}, \quad g = \frac{Gm}{r^2}
\]

- Analyze graphs for $F_g$ vs. $r$ and $g$ vs. $r$; identify their shape, outside of the objects, to be an inverse-square.

**Topic: Waves and Sound**

**Standards**

5.2 Strand E

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

Objects undergo different kinds of motion (translational, rotational, and vibrational).

**Enduring Understandings**

- For a phenomenon to be considered a wave, it must exhibit all four of the defining properties: reflection, refraction, diffraction, and interference.
- We encounter waves and wave-like phenomenon in many facets of our lives.
- The speed of a wave is determined by the medium through which it travels.

**Essential Questions**

- What is a wave?
- How can energy be transferred without a transfer of matter?
- How do we use waves in our everyday lives?
- What phenomenon have wave-like motion, even though they are not waves themselves?

**Skills and Objectives**

Students will know:

- Definitions of wave, source, medium, crest, trough, amplitude, cycle, period, wavelength, frequency, wavefront, ray, mechanical wave, electromagnetic wave, transverse wave, longitudinal wave, compression, rarefaction, disturbance, pulse, periodic wave.
- Definitions of reflection, refraction, diffraction, and interference.
- For sound, amplitude determines volume and frequency determines pitch.

Students will be able to:
Use and manipulate equations: \[ v = f l = 1 / T \quad f = 1 / T \quad v_{\text{sound}} = 331 \text{ m/s} + (0.6 \text{ m/s}^2/\text{C})T \]
\[ T = 2 \pi (L / g)^{1/2} \]

- Analyze pictures of waves to determine/measure its characteristics
- Draw pictures of waves with given specifications
- Recognize the defining properties of waves, their consequences, and how we observe them in our everyday lives
- Determine that sound is a wave by showing it exhibits all four defining properties of waves
- Predict how a wave will change at a boundary; recognizing that, at a boundary, some of the wave energy transmits, some bounces back, and some is absorbed
- Recognize Doppler effect and its consequences
- Study the motion of a pendulum to show that its period is determined solely by its length
- Determine that, while the motion of a pendulum can be described by many characteristics of a wave, it itself is not a wave

**Topic: Light**

**Standards**

5.2 Strand A

Objects vary in the extent to which they absorb and reflect light and conduct heat (thermal energy) and electricity.

5.2 Strand C

Light travels in a straight line until it interacts with an object or material.

Light can be absorbed, redirected, bounced back, or allowed to pass through. The path of reflected or refracted light can be predicted.

Visible light from the Sun is made up of a mixture of all colors of light. To see an object, light emitted or reflected by that object must enter the eye.

Energy is transferred from place to place. Light energy can be thought of as traveling in rays. Thermal energy travels via conduction and convection.

**Enduring Understandings**

- For a phenomenon to be considered a wave, it must exhibit all four of the defining properties: reflection, refraction, diffraction, and interference.
- The speed of light is the ultimate speed limit in the Universe; as objects approach the speed of light, space and time change around them.
- Light is the only thing we see.
- Light has a dual nature – it exhibits the properties of waves, but it sometimes acts like a particle.
- Light is not just what we can see (visible); it is a whole range of radiation.

**Essential Questions**

- Is light just what we can see?
- How can we use light’s wave properties to our advantage?
- How can we use light’s particle properties to our advantage?
- Why is the sky blue?

**Skills and Objectives**

Students will know:

- Light is produced by nuclear reactions or by accelerating electric charges
- The frequency of light determines its place in the spectrum (color for visible light)
- The frequency of light determines its energy
Students will be able to:

- Review defining properties of waves and how they relate to light
- Read an electromagnetic spectrum
- Use and manipulate speed equation for light: \( c = \lambda f \), where \( c = 3.0 \times 10^8 \) m/s
- Use the law of reflection: \( q_1 = q_2 \)
- Use and manipulate Snell’s Law of refraction: \( n_1 \sin q_1 = n_2 \sin q_2 \)
- Use and manipulate the equation for critical angle: \( q_c = \sin^{-1}(n_2/n_1) \)
- Identify dispersion as a consequence of refraction
- Identify converging and diverging mirrors from their shapes
- Apply reflection concepts to curved and plane mirrors
- Identify converging and diverging lenses from their shapes
- Apply refraction concepts to converging and diverging lenses
- Construct ray diagrams for single-lens systems, and by doing so, be able to determine whether an image will be real or virtual; upright or inverted; magnified, reduced, or life-size
- Explain how rainbows form
- Identify diffraction phenomena
- Study the photoelectric effect and how its results led to the understanding that light can act as a particle, known as a photon
- Use and manipulate equation for energy of a photon: \( E_{\text{photon}} = hf \) where \( h = 6.63 \times 10^{-34} \) Js

**Topic: Electrostatics**

**Standards**

5.2 Strand A

Properties of solids, liquids, and gases are explained by a model of matter as composed of tiny particles (atoms) in motion.

Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge.

The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.

Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.

In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons.

Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.

5.2 Strand E

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

The motion of an object changes only when a net force is applied.

The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship \( (a=F_{\text{net}}/m) \) is independent of the nature of the force.

**Enduring Understandings**

- All matter is composed of atoms.
• Atoms are incredibly small, but they have a substructure to them, so there are particles smaller than the atom.
• Atoms are mostly empty space; understanding the spatial dimensions requires a major perspective change.
• Charge is a fundamental quantity that some objects have that let them interact with other objects that have charge.
• Law of Conservation of Charge: Charge can be neither created nor destroyed – only transferred.
• There are only four fundamental interactions in the Universe: gravitational, electromagnetic, strong nuclear, and weak nuclear; scientists are trying to find similarities among them in an attempt to unify them and simplify our studies of them.
• Objects have potential energy when they are in position or location that they do not “want to be.”

**Essential Questions**

- What is charge?
- How do charges interact?
- How does an understanding of electrical phenomena impact and inform our everyday lives?

**Skills and Objectives**

Students will know:

- Definitions of conductor, insulator, potential (difference), field
- Charge is quantized and conserved
- Electrons are free to move within and between objects, whereas protons and neutrons are stuck inside their nuclei
- Opposite charges attract; like charges repel.
- Conductors easily allow the flow of charge because they have a loose hold on their electrons; insulators do not
- Charging an object can occur through friction, contact, or induction
- Electric fields can be illustrated by drawing vectors that show the direction of the force on a positive test charge in the vicinity of the charges generating the field

Students will be able to:

- Study the structure of the atom; know mass, charge, and location of proton, neutron, and electron
- Study the hierarchy of matter in terms of size, from large-scale objects down to the most basic: quarks and leptons
- Study the Rutherford Gold Foil experiment that established the presence of the nucleus and the relative emptiness of the atom
- Use and manipulate equations: \( F_e = kq_1q_2 / r^2 \) \( E = F / q \) \( PE = qEd \)
- Use analogies between gravitational phenomena and electrical phenomena to further understand the two
- Draw electric fields for simple arrangements of charges: single positive, single negative, dipole, two positives, two negatives, oppositely charged parallel plates
- Use an electroscope to analyze the motion of charges and how objects attain a charge
- Study the production of lightning

**Topic: Circuits**
### Standards

5.2 Strand D

Electrical circuits require a complete loop through conducting materials in which an electrical current can pass. The flow of current in an electric circuit depends upon the components of the circuit and their arrangement, such as in series or parallel. ***Electricity*** flowing through an electrical circuit produces magnetic effects in the wires.

### Enduring Understandings

- Electricity is a form of energy that results from the motion of electric charges.
- An understanding of electricity is what makes all of our modern conveniences possible.

### Essential Questions

- What can we do with electricity?
- How do we maintain the flow of charge?

### Skills and Objectives

Students will know:

- Definitions of current, conventional current, voltage, resistance, series circuit, parallel circuit
- For historical reasons, we follow the motion of positive charges in circuits, even though protons do not flow
- To maintain the flow of charges, it is required to have a potential difference, a conducting path, and a complete path
- Resistance results from the collisions of charges inside the circuit, which limits their flow

Students will be able to:

- Light ‘light bulbs’ in simple circuits, series circuits, and parallel circuits
- Describe series and parallel circuits in terms of the physical arrangements and in terms of how resistors (specifically light bulbs) behave differently
- Use analog voltmeters and ammeters
- Use and manipulate equations:  \( I = \frac{q}{t} \)  \( V = IR \)  \( R_{eq} = R_1 + R_2 + \ldots \)  \( \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \)  \( P = IV = I^2R = \frac{V^2}{R} \)
- Use analogies from gravitational phenomena to enhance the understanding of electrical phenomena
- Recognize that not all devices follow Ohm’s Law and why that happens
- Analyze graphs; determining what the slope represents

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### Topic: Magnetism

### Standards

5.2 Strand E

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time. The motion of an object changes only when a net force is applied. The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship (\( a = \frac{F_{net}}{m} \)) is independent of the nature of the force.

### Enduring Understandings

- Fields are how objects affect the space that surrounds them.
- Opposites attract; likes repel.
- Magnets are not electrically charged, but there is a connection between electricity and magnetism.
• The Earth acts like a bar magnet.
• There are no magnetic monopoles.
• There are connections between electricity and magnetism that impact our lives on a daily basis.

**Essential Questions**
• How can we test the existence of a field?
• How can we picture a magnetic field?
• What makes a magnet?
• What is the connection between electricity and magnetism?
• How is the connection between electricity and magnetism used in our everyday lives?

**Skills and Objectives**

Students will know:
• Each piece of a broken magnet attains a north and south pole
• Magnetic fields are caused by moving charged particles
• Current can induce a magnetic field; a changing magnetic field can induce current
• Electromagnetic radiation (light) is the result of a varying combination of electric and magnetic fields

Students will be able to:
• Understand how to use a compass to track magnetic field lines
• Identify two poles of magnets and how they interact with each other: likes repel; opposites attract
• Explain how an object can attain the properties of a magnet
• Understand that some materials are intrinsically magnetic, while some hold the properties for a finite amount of time
• Draw magnetic fields around bar magnets and combinations of magnets
• Use the right-hand rule for direction of field lines and for force on a moving charged particle

**21st Century Connections**

**Character Education:**
• **Honesty:** Students are held accountable for the veracity of their data in laboratory investigations. The issue of plagiarism is discussed in detail, as are the consequences of engaging in such acts.
• **Respect:** Discussions are meant to challenge students’ pre- and misconceptions about the world around them. As such, students are encouraged to maintain an open mind throughout.
• **Responsibility:** Safety is emphasized when handling lab equipment.
Career Education:
- 9.1.B Communicate and comprehend written and verbal thoughts, ideas, directions, and information relative to educational and occupational settings.
- 9.1.B Select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.
- 9.2.A Apply communications and data analysis to the problem-solving and decision making processes in a variety of life situations.
- 9.2.A Apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.
- 9.2.F Practice the safe use of tools and equipment.

Cross Curricular:
- Mathematics: Equations, graphs, algebra, geometry, and trigonometry are used on a daily basis to analyze the physical world around us.
- History: Prominent scientists are discussed. Their contributions to science are detailed, and they are placed in context with other concurrent world events.

Technology:
- 8.1.12.A.2 Produce and edit a multi-page document for a commercial or professional audience using desktop publishing and/or graphic software.

Suggested Pacing Chart

<table>
<thead>
<tr>
<th>Topic</th>
<th>Approximate Number of Blocks (including Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Physics, Measurement, and Units</td>
<td>6</td>
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<tr>
<td>Linear Motion</td>
<td>7.5</td>
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<tr>
<td>Free Fall</td>
<td>3.5</td>
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<tr>
<td>Vectors and Newton’s Laws</td>
<td>8.5</td>
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<tr>
<td>Impulse and Momentum</td>
<td>4</td>
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<tr>
<td>Projectile Motion</td>
<td>6.5</td>
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<td>Work and Energy</td>
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<tr>
<td>Circular Motion and Universal Gravitation</td>
<td>6</td>
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<td>Waves and Sound</td>
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<td>Light</td>
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<td>Electrostatics</td>
<td>6</td>
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<td>Circuits</td>
<td>8</td>
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<tr>
<td>Magnetism</td>
<td>4</td>
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</tbody>
</table>
Overview:

Physics is the study of matter and its motion, the causes of changes in motion and energy. Physics I (Honors) will prepare students to be competitive in AP Physics or other college level Physics courses.

Regardless of which course a student chooses, all SBHS students will develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment in alignment with New Jersey Core Content Standards for Science.
Content: Curriculum for Honors Physics

Philosophy: The Honors Physics course is an extension of the material presented in the Physics 1 course. It is an introductory course that presents the same concepts as Physics 1, but in more depth and with more rigor. It is not, in any way, intended to prepare students to take the AP Physics B exam. Students who want to take the AP Physics B exam should sign up for the AP Physics B course. The optional topics of Heat and Thermodynamics and Atomic and Nuclear Physics are presented in this curriculum, should the teacher have time to touch on them. They are not required.

Textbook: College Physics, 7th edition by Serway and Faughn

New Jersey Science Standards:
The following standards have been covered in this curriculum:
5.2.4.A.4
5.2.8.A.3
5.2.12.A.1, 2, 4
5.2.6.C.1, 2
5.2.8.C.2
5.2.4.D.1
5.2.6.D.1
5.2.8.D.1
5.2.12.C.1, 2
5.2.12.D.1, 4
5.2.12.E.1, 2, 3, 4

<table>
<thead>
<tr>
<th>Topic: Introduction to Physics, Measurement, and Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enduring Understandings</strong></td>
</tr>
<tr>
<td>- People need a common language if we expect to communicate with each other.</td>
</tr>
<tr>
<td>- Words often have one meaning in everyday language and another, more specific meaning, in science.</td>
</tr>
<tr>
<td>- Models are a way to simplify our understanding of something that is too extreme to be studied under normal conditions.</td>
</tr>
<tr>
<td>- No experiment can ever be called a failure.</td>
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<tr>
<td>- The laws and theories of science are not “written in stone.”</td>
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</tbody>
</table>

<table>
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<tr>
<th>Essential Questions</th>
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</thead>
<tbody>
<tr>
<td>- How does math relate to science?</td>
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<tr>
<td>- What constitutes a failed experiment?</td>
</tr>
<tr>
<td>- When do we use science in our everyday lives?</td>
</tr>
<tr>
<td>- Why do we need units?</td>
</tr>
<tr>
<td>- Is it acceptable to change a scientific law or theory?</td>
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<table>
<thead>
<tr>
<th>Skills and Objectives</th>
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<tbody>
<tr>
<td>Students will be know:</td>
</tr>
<tr>
<td>- Definitions and differences among fact, theory, and law</td>
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<tr>
<td>- Definition and difference between hypothesis and opinion</td>
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<tr>
<td>- Definition and difference between precision and accuracy</td>
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<tr>
<td>Students will be able to:</td>
</tr>
</tbody>
</table>
- Manipulate units in combinations (6 m x 7 m = 42 m²)
- Estimate distances in metric units

**Topic: One-Dimensional Kinematics**

**Standards**
5.2.12.E.1

**Enduring Understandings**
- An understanding of the concepts of motion broadens everyone’s lives.
- Words often have one meaning in everyday language and another, more specific meaning, in science.
- Motion can be depicted visually, most usefully through graphs.
- The slope and shape of a graph have meaning.

**Essential Questions**
- How do the concepts of motion figure in to our everyday life?
- What accelerates?
- When is an object accelerating?
- What is the difference between velocity and acceleration?
- Why do we need to be able to convert units?
- How can we visually represent motion?

**Skills and Objectives**

Students will know:
- Definitions of time, distance, average speed, average velocity, acceleration, displacement, instantaneous speeds and velocities, vector, and scalar
- Unit conversions

Students will be able to:
- Use and manipulate equations:  
  \[ \frac{v_{avg}}{t} = \frac{x}{t} \quad a = \frac{v}{t} \quad v_{avg} = \frac{v_o + v_f}{2} \]
  \[ \Delta x = v_o t + \frac{1}{2} at^2 \quad v_f^2 = v_o^2 + 2a \Delta x \]
- Manipulate units of speed and acceleration: [m/s] and [m/s²]
- Identify the three ways to change velocity or to accelerate
- Plot data for constant velocity and accelerated motion
- Analyze graphs of motion – calculating slope, telling a story of an object’s motion

**Topic: Free Fall**

**Standards**
5.2.12.E.1, 3

**Enduring Understandings**
- Words often have one meaning in everyday language and another, more specific meaning, in science.
- The slope and shape of a graph have meaning.
- All objects in free fall experience the same acceleration.
- Velocity is motion, and acceleration is how motion changes.
- Free fall motion is symmetric about the midpoint.

**Essential Questions**
- What does it mean for an object to be in free fall?
- What is the difference between velocity and acceleration?

**Skills and Objectives**
Students will know:
- Definitions of air resistance, vacuum, and free fall
- Graph velocity vs. Time and distance vs. Time graphs for free fall motion

Students will be able to:
- Identify various ways to set an object into free fall motion
- Apply equations learned in 1-D Kinematics to the specific case of free fall
- Link equations (linear and quadratic) to the shapes of the graphs they produce
- Identify the importance of setting a positive direction when dealing with vectors that point in opposite directions
- Analyze graphs of motion – calculating slope

**Topic: Vectors and Newton’s Laws**

**Standards**
5.2.12.E.1, 3, 4

**Enduring Understandings**
- Words often have one meaning in everyday language and another, more specific meaning, in science.
- Vector addition is commutative.
- An object’s motion in one dimension can be treated independently of its motion in other dimensions.
- The slope and shape of a graph have meaning.
- An understanding of inertia, mass, and force broaden our everyday lives.
- Newton’s three Laws of Motion:
  1. An object tends to maintain its current state of motion unless acted upon by an outside force.
  2. The net force on an object determines its acceleration.
  3. For every action, there is an equal and opposite reaction. (Forces come in equal and opposite pairs that occur at the same time.)
- The motion of any object can be described as either equilibrium or not equilibrium.
- Friction is always present (we do not live in a perfect world).

**Essential Questions**
- How do vector quantities combine?
- What accelerates?
- What causes an object to accelerate?
- How do the concepts of inertia, mass, and force affect our daily lives?
- What is the difference between mass and weight?
- What are the consequences of being in equilibrium? Of not being in equilibrium?

**Skills and Objectives**

Students will know:
- Definitions of resultant and components
- Definitions of force, inertia, weight, and mass
- Friction always acts against the direction of motion

Students will be able to:
- Find the magnitude and direction of the resultant of adding vectors
- Use and manipulate the basic trigonometric functions (sine, cosine, and tangent) and their corresponding inverse functions
- Resolve a vector into two components
- Use and manipulate equations for force: \( \vec{F} = ma \) \( w = mg \)
- Manipulate units of force: \( [\text{kg} \cdot \text{m/s}^2] = [\text{n}] \)
- Construct and analyze free-body diagrams building up equations of net force
- Use and manipulate equations for static and kinetic friction: \( f = \mu n \)
- Analyze graphs of motion – calculating slope
- Study special cases in forces, such as inclined planes and multi-body systems

**Topic: Impulse and Momentum**

**Standards:**
- 5.2.12.D.4
- 5.2.12.E.1, 3, 4

**Enduring Understandings**
- Law of Conservation of Momentum: The vector sum of all moments in a closed system is conserved.

**Essential Questions**
- What is the advantage to using impulse and momentum techniques to solve a problem, as opposed to using Newton’s Laws?

**Skills and Objectives**

**Students will know:**
- Definitions of impulse, momentum, conserved, closed system
- Law of conservation of momentum: \( m_1v_1 + m_2v_2 + \ldots = m_1v_1' + m_2v_2' + \ldots \)

**Students will be able to:**
- Use and manipulate relevant equations: \( j = \vec{F} \cdot \Delta t \) \( j_{\text{net}} = \vec{F}_{\text{net}} \cdot \Delta t = \vec{p} \) \( p = mv \)
- Manipulate units of impulse and momentum: \( [\text{n} \cdot \text{s}] = [\text{kg} \cdot \text{m/s}] \)
- Apply vector addition to impulse and momentum problems with a single object
- Identify the momentum in a closed system before and after an interaction between two objects
- Understand the importance of setting a positive direction when dealing with vectors that point in opposite directions
- Applying the law of conservation of momentum to analyze one-dimensional interactions within 2-object systems, systems with more than two objects, and interactions in two dimensions

**Topic: Two-Dimensional Kinematics**

**Standards**
- 5.2.12.E.1, 3, 4

**Enduring Understandings**
- The slope and shape of a graph have meaning.
- An object’s motion in one dimension can be treated independently of its motion in other dimensions.
- All objects in free fall experience the same acceleration.
- Velocity is motion, and acceleration is how motion changes.
- Free fall motion is symmetric about the midpoint.

**Essential Questions**
- What does it mean for an object to be in free fall?
- What are the advantages to treating projectile motion as independent 1-dimensional motions?
- What is the difference between velocity and acceleration?

**Skills and Objectives**
Students will know:
- Definitions of projectile, trajectory, and range

Students will be able to:
- Resolve vectors into components and finding resultant velocities from components
- Apply equations learned in one-dimensional kinematics, free fall, and vectors and newton’s laws to the specific case of 2-dimensional projectile motion
- Graph velocity vs. Time and distance vs. Time graphs for free fall motion
- Link equations (linear and quadratic) to the shapes of the graphs they produce
- Identify the importance of setting a positive direction when dealing with vectors that point in opposite directions
- Analyze graphs of motion – calculating slope
- Understand the relationship between range and angle; discovering that 45° gets the maximum range for a projectile

**Topic: Work and Energy**

**Standards**
- 5.2.8.D.1
- 5.2.12.D.1, 4
- 5.2.12.E.1, 3, 4

**Enduring Understandings**
- Words often have one meaning in everyday language and another, more specific meaning, in science.
- **Law of Conservation of Energy:**
  In general, energy cannot be created or destroyed – only transferred from one object to another or changed from one form to another.
- **Mechanical energy is conserved when gravity (a conservative force) drives the system and friction is eliminated.**
- **Work done by, or against, gravity (or any conservative force) is path-independent.**
- **Objects have potential energy when they are in position or location that they do not “want to be.”**
- **Friction is always present (we do not live in a perfect world).**

**Essential Questions**
- How do the concepts of work, energy, and power affect our daily lives?
- When is work done?
- What is the difference between work and power?
- How can we use the conservation of mechanical energy to our advantage?
- When is mechanical energy conserved and when is it not?

**Skills and Objectives**

Students will know:
- Definitions of work, kinetic energy, potential energy, mechanical energy, power
- Besides mechanical energy (kinetic and potential), there are the non-mechanical forms of energy which impact our daily lives

Students will be able to:
- Use and manipulate equations for work, energy, and power:
  \[ W = F \cdot x \cdot \cos \theta \]
  \[ KE = \frac{1}{2}mv^2 \]
  \[ W_{net} = \Delta KE \]
  \[ pe_g = mgh \]
\[ F_c = -kx \quad \text{pes} = \frac{1}{2} kx^2 \quad P = \frac{W}{t} = F_{\text{avg}} \cos\theta \]

- Manipulate units of work, energy, and power: \([kg \cdot m^2/s^2] = [N \cdot m] = [J] \quad [J/s] = [W]\)
- Analyze pictures of motion to determine if (+), (-), or no work is done
- Use conservation of mechanical energy to solve mechanics problems
- Apply the general relationship among mechanical energies and non-conservative work:
  \[ W_{nc} + KE_o + PE_o = KE_f + PE_f \]

**Topic:** Circular Motion and Universal Gravitation

**Standards**
5.2.12.E.1, 2, 3, 4

**Enduring Understandings**
- Circular motion can be observed in all facets of nature; the properties we study in the classroom can be applied to all scales, from the smallest (atoms) to the largest (planets and stars).
- Law of Universal Gravitation: All objects attract all other objects with a force that depends on their masses and the distance of separation.
- Objects create gravitational fields; other objects interact with those fields.
- Gravity, though experienced every day in a very basic manner, is still not fully understood in terms of how it relates to the other fundamental interactions.

**Essential Questions**
- What goes in circles?
- Is normal force always equal to weight?
- If we seem to feel centrifugal force, why is it called a fake force?
- If all objects are attracted to all other objects, why do we not always feel those attractive forces?

**Skills and Objectives**

**Students will know:**
- Definitions of tangential speed, period, uniform circular motion, centripetal (acceleration and force), field, gravitational field
- Isaac Newton invented calculus to solve the problem of linking Earth-bound studies of gravity with the motion of heavenly bodies; in doing so, he developed the Law of Universal Gravitation
- Fields are ways for us to describe how an object can influence the motion of other objects without contact
- The gravitational field of an object drops off quickly with distance
- The equations for \( F \) and \( g \) only work outside the objects; inside a spherically symmetric body of uniform density, for example, \( g \) varies linearly with distance from the center
- Albert Einstein suggested a totally different view of gravity – that all objects bend the fabric of space-time in their vicinity; this view agrees with Newton’s view, mathematically

**Students will be able to:**
- Clearly understand that centripetal force is not a new kind of force; rather, it is another name for net force in circular motion
- Draw free-body diagrams to analyze how forces must combine to create circular motion
- Investigate the consequences of traveling in a vertical circle at speeds above or below the minimum or maximum speeds to continue in circular motion (depending on the situation)
- Use and manipulate equations:
  \[ v = 2\pi r/T \quad a_c = v^2/r \quad F_c = m \frac{v^2}{r} \]
\[ F_g = \frac{Gm_1m_2}{r^2} \quad g = \frac{Gm}{r^2} \]

- Analyze graphs for \( F_g \) vs. \( R \) and \( g \) vs. \( R \); identify their shape, outside of the objects, to be an inverse-square.

**Topic: Vibrations, Waves, and Sound**

**Standards**
5.2.12.E.1, 2

**Enduring Understandings**

- For a phenomenon to be considered a wave, it must exhibit all four of the defining properties: reflection, refraction, diffraction, and interference.
- We encounter waves and wave-like phenomenon in many facets of our lives.
- The speed of a wave is determined by the medium through which it travels.

**Essential Questions**

- What is a wave?
- How can energy be transferred without a transfer of matter?
- How do we use waves in our everyday lives?
- What phenomena have wave-like motion, even though they are not waves themselves?

**Skills and Objectives**

Students will know:

- Definitions of wave, source, medium, crest, trough, amplitude, cycle, period, wavelength, frequency, wavefront, ray, mechanical wave, electromagnetic wave, transverse wave, longitudinal wave, compression, rarefaction, disturbance, pulse, periodic wave
- Definitions of reflection, refraction, diffraction, and interference
- Definition of simple harmonic motion, restoring force
- For sound, amplitude determines volume and frequency determines pitch

Students will be able to:

- Use and manipulate equations: \( v = f \cdot \frac{\Box}{T} \quad f = \frac{1}{T} \quad v_{\text{sound}} = 331 \text{ m/s} + (0.6 \text{ m/s}^2 c) T_c \quad T = 2 \sqrt{\left(\frac{L}{g}\right)^{1/2}} \)
- Analyze pictures of waves to determine/measure its characteristics
- Draw pictures of waves with given specifications
- Recognize the defining properties of waves, their consequences, and how we observe them in our everyday lives
- Determine that sound is a wave by showing it exhibits all four defining properties of waves
- Predict how a wave will change at a boundary; recognize that, at a boundary, some of the wave energy transmits, some bounces back, and some is absorbed
- Recognize Doppler effect and its consequences
- Study the motion of a pendulum to show that its period is determined solely by its length
- Determine that, while the motion of a pendulum can be described by many characteristics of a wave, it itself is not a wave
- Use and manipulate equations for springs: \( F_s = -kx \quad T = 2 \sqrt{\frac{m}{k}}^{1/2} \)

**Topic: Light**

**Standards**
5.2.4.A.4,
5.2.6.C.1, 2
5.2.8.C.2

**Enduring Understandings**
For a phenomenon to be considered a wave, it must exhibit all four of the defining properties: reflection, refraction, diffraction, and interference.

The speed of light is the ultimate speed limit in the Universe; as objects approach the speed of light, space and time change around them.

Light is the only thing we see.

Light has a dual nature – it exhibits the properties of waves, but it sometimes acts like a particle.

Light is not just what we can see (visible); it is a whole range of radiation.

**Essential Questions**

- Is light just what we can see?
- How can we use light’s wave properties to our advantage?
- How can we use light’s particle properties to our advantage?
- Why is the sky blue?

**Skills and Objectives**

**Students will know:**

- Light is produced by nuclear reactions or by accelerating electric charges
- The frequency of light determines its place in the spectrum (color for visible light)
- The frequency of light determines its energy

**Students will be able to:**

- Review defining properties of waves and how they relate to light
- Read an electromagnetic spectrum
- Use and manipulate speed equation for light: \( c = \lambda f \), where \( c = 3.0 \times 10^8 \) m/s
- Use the law of reflection: \( \theta_1 = \theta_2 \)
- Use and manipulate equation for index of refraction: \( n = \frac{c}{v} \)
- Use and manipulate Snell’s law of refraction: \( n_1 \sin \theta_1 = n_2 \sin \theta_2 \)
- Use and manipulate the equation for critical angle: \( \theta_c = \sin^{-1}(n_2/n_1) \)
- Identify dispersion as a consequence of refraction
- Identify converging and diverging mirrors from their shapes
- Apply reflection concepts to curved and plane mirrors
- Identify converging and diverging lenses from their shapes
- Apply refraction concepts to converging and diverging lenses
- Use and manipulate equations for thin-lenses and curved mirrors:
  \[ R = 2f \quad \frac{1}{f} = \frac{1}{p} + \frac{1}{q} \quad M = \frac{h_i}{h_o} = -\frac{p}{q} \]
- Construct ray diagrams for single-lens systems, and by doing so, be able to determine whether an image will be real or virtual; upright or inverted; magnified, reduced, or life-size
- Explain how rainbows form
- Identify diffraction phenomena
- Use and manipulate equations for single- and double-slit diffraction and diffraction gratings:
  \[ m \lambda = d \sin \theta \quad m \lambda = a \sin \frac{\theta}{2} \]

**Topic: Electrostatics**

**Standards**

5.2.8.A.3,
5.2.12.A.1, 2, 4
5.2.12.E.1, 3, 4
Enduring Understandings

- All matter is composed of atoms.
- Atoms are incredibly small, but they have a substructure to them, so there are particles smaller than the atom.
- Atoms are mostly empty space; understanding the spatial dimensions requires a major perspective change.
- Charge is a fundamental quantity that some objects have that let them interact with other objects that have charge.
- Law of Conservation of Charge:
  Charge can be neither created nor destroyed – only transferred.
- There are only four fundamental interactions in the Universe: gravitational, electromagnetic, strong nuclear, and weak nuclear; scientists are trying to find similarities among them in an attempt to unify them and simplify our studies of them.
- Objects have potential energy when they are in position or location that they do not “want to be.”

Essential Questions

- What is charge?
- How do charges interact?
- How does an understanding of electrical phenomena impact and inform our everyday lives?

Skills and Objectives

Students will know:

- Definitions of conductor, insulator, potential (difference), field
- Charge is quantized and conserved
- Electrons are free to move within and between objects, whereas protons and neutrons are stuck inside their nuclei
- Opposite charges attract; like charges repel.
- Conductors easily allow the flow of charge because they have a loose hold on their electrons; insulators do not
- Charging an object can occur through friction, contact, or induction
- Electric fields can be illustrated by drawing vectors that show the direction of the force on a positive test charge in the vicinity of the charges generating the field

Students will be able to:

- Study the structure of the atom; know mass, charge, and location of proton, neutron, and electron
- Study the hierarchy of matter in terms of size, from large-scale objects down to the most basic: quarks and leptons
- Study the Rutherford Gold Foil experiment that established the presence of the nucleus and the relative emptiness of the atom
- Use and manipulate equations:  $F_e = k|q_1||q_2|/r^2$  \[E = F_e/|q|\]  \[E = k|q|/r^2\]  \[PE = |q|Ed\]  \[V = kq/r\]  \[\nabla V = -W_E/|q|\]  \[\nabla V = E\nabla d\]
- Use analogies between gravitational phenomena and electrical phenomena to further understand the two
- Draw electric fields for simple arrangements of charges: single positive, single negative, dipole, two positives, two negatives, oppositely charged parallel plates
- Use an electroscope to analyze the motion of charges and how objects attain a charge
• Use equipotential lines to map electric fields, using the definition that lines of equal potential are at right angles to electric field lines
• Study how capacitors store charge
• Use and manipulate capacitor equations: \( C = \frac{Q}{\Delta V} = \frac{\epsilon_0 A}{d} \quad C_{eq} = C_1 + C_2 + \ldots \)
  \( \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots \quad PE_c = \frac{1}{2} Q \Delta V \)
• Study the production of lightning

**Topic: Circuits**

**Standards**
5.2.4.D.1
5.2.6.D.1

**Enduring Understandings**

• Electricity is a form of energy that results from the motion of electric charges.
• An understanding of electricity is what makes all of our modern conveniences possible.

**Essential Questions**

• What can we do with electricity?
• How do maintain the flow of charge?

**Skills and Objectives**

Students will know:

• Definitions of current, conventional current, voltage, resistance, series circuit, parallel circuit
• For historical reasons, we follow the motion of positive charges in circuits, even though protons do not flow
• To maintain the flow of charges, it is required to have a potential difference, a conducting path, and a complete path
• Resistance results from the collisions of charges inside the circuit, which limits their flow
• Definitions of internal resistance, terminal voltage, and emf

Students will be able to:

• Light ‘light bulbs’ in simple circuits, series circuits, and parallel circuits
• Describe series and parallel circuits in terms of the physical arrangements and in terms of how resistors (specifically light bulbs) behave differently
• Use analog voltmeters and ammeters
• Use and manipulate equations: \( I = \frac{q}{t} \quad \Delta V = IR \quad R_{eq} = \frac{R_1 + R_2 + \ldots}{1} \quad P = I \Delta V = I^2R = (\Delta V)^2 / R \)
• Use analogies from gravitational phenomena to enhance the understanding of electrical phenomena
• Use and manipulate equation for emf: \( \Delta V_b = \text{emf} - Ir \)
• Recognize that not all devices follow Ohm’s Law and why that happens
• Analyze graphs; determining what the slope represents

**Topic: Magnetism**

**Standards**
5.2.12.E.1, 3, 4

**Enduring Understandings**

• Fields are how objects affect the space that surrounds them.
• Opposites attract; likes repel.
• Magnets are not electrically charged, but there are connections between electricity and
magnetism.

- The Earth acts like a bar magnet.
- There are no magnetic monopoles.
- There are connections between electricity and magnetism that impact our lives on a daily basis.

**Essential Questions**

- How can we test the existence of a field?
- How can we picture a magnetic field?
- What makes a magnet?
- What are the connections between electricity and magnetism?
- How are the connections between electricity and magnetism used in our everyday lives?

**Skills and Objectives**

Students will know:

- Each piece of a broken magnet attains a north and south pole
- Magnetic fields are caused by moving charged particles
- Current can induce a magnetic field; a changing magnetic field can induce current
- Electromagnetic radiation (light) is the result of a varying combination of electric and magnetic fields

Students will be able to:

- Understand how to use a compass to track magnetic field lines
- Identify two poles of magnets and how they interact with each other: likes repel, and opposites attract
- Explain how an object can attain the properties of a magnet
- Understand that some materials are intrinsically magnetic, while some hold the properties for a finite amount of time
- Draw magnetic fields around bar magnets and combinations of magnets
- Use and manipulate equations: \( f_m = qv \sin \theta \)  
  \( f_m = il \sin \theta \)  
  \( b = q \cdot i / 2 \pi r \)  
  \( = \mu_0 \cdot i / 2 \pi r \)  
- Use the right-hand rule for direction of b field lines and for force on a moving charged particle

**Optional Topic: Heat and Thermodynamics**

**Standards**

5.2.8.A.3  
5.2.12.C.1, 2

**Enduring Understandings**

Heat is not temperature.

Gases follow the Laws of Thermodynamics:

- If object A is in thermal equilibrium with object B and object B is in thermal equilibrium with object C, then object A is in thermal equilibrium with object C.
- The change in internal energy of a system is the sum of the work done on that system plus the heat added into the system.
- In any cyclical process, the amount of heat energy added in will never be equal to the amount of work done by the process; some will always be lost to unrecoverable forms of energy. Stated another way, the entropy of a system, left to itself, will always increase.

Gases behave in predictable manners that allow us to use them to our advantage.

**Essential Questions**
- What is the difference between heat and temperature?
- How can we use gases to our advantage?
- Why is it that a cyclical process can never be 100% efficient?

### Skills and Objectives

**Students will know:**
- Definitions of heat, temperature, internal energy, absolute zero, pressure, volume, density, mole, efficiency
- Definition of Avogadro’s number: \( N_A = 6.02 \times 10^{23} \text{ particles / mole} \)

**Students will be able to:**
- Convert among the different temperature scales: Fahrenheit, Celsius, and Kelvin
- Use and manipulate equation for pressure and work: \( P = F/A \quad W = -P \Delta V \)
- Use and manipulate the equations for number of moles: \( n = N/N_A = m/M \)
- Use and manipulate the Ideal Gas Law: \( PV = nRT \)
- Use and manipulate the equation for the First Law of Thermodynamics: \( \Delta U = Q + W \)
- Use and manipulate equation for internal energy: \( \Delta U = 3/2nRT = 3/2 \Delta (PV) \)
- Analyze P-V diagrams for standard thermodynamic processes: isobaric, isometric, isothermal, adiabatic, and for cycles
- Use and manipulate equation for efficiency: \( e = (Q_H - Q_L)/Q_H = W_{eng}/Q_H \)

### Optional Topic: Atomic and Nuclear Physics

**Standards**
- 5.2.12.A.1, 4
- 5.2.12.D.3

**Enduring Understandings**
- Light has a dual nature – it exhibits the properties of waves, but it sometimes acts like a particle.
- Particles can act like waves.
- The Universe is stranger than our everyday experience shows us.
- The nucleus of an atom stores tremendous amounts of energy.
- Mass and energy are flip sides of the same coin.
- Law of Conservation of Mass-Energy: Mass-energy can be neither created nor destroyed – only transferred from one object to another or from one form to another.

**Essential Questions**
- How can we use light’s particle nature to our advantage?
- How can we use the wave-like nature of particles to our advantage?
- How can we harness the energy stored in a nucleus?

**Skills and Objectives**

**Students will know:**
- Definitions of energy levels, mass defect, binding energy, photon, deBroglie wavelength
- Under controlled conditions, the wave-like nature of particles can be observed

**Students will be able to:**
- Study the photoelectric effect and how its results led to the understanding that light can act as a particle, known as a photon
- Use and manipulate equation for energy of a photon: \( e_{\text{photon}} = hf \quad \text{where} \quad h = 6.63 \times 10^{-34} \text{j} \)
- Use and manipulate equation for photoelectrons: \( k_{e_{\text{max}}} = hf \star \star \star \)
- Study Bohr’s model of the atom and the more current Schrödinger cloud model of the atom
- Understand the transitions that electrons go through when they change energy levels by releasing or absorbing energy
- Use and manipulate equation for de Broglie wavelength and momentum of photons: \( p = \frac{h}{\lambda} \)
- Use and manipulate equation for mass-energy equivalence: \( E = mc^2 \)

### Assessments:
Will include but not be limited to:
- Quizzes
- Tests
- Projects
- Lab Reports

### 21st Century Connections:

**Character Education:**
- Honesty: Students are held accountable for the veracity of their data in laboratory investigations. The issue of plagiarism is discussed in detail, as are the consequences of engaging in such acts.
- Respect: Discussions are meant to challenge students’ pre- and misconceptions about the world around them. As such, students are encouraged to maintain an open mind throughout.
- Responsibility: Safety is emphasized when handling lab equipment.

**Career Education:**
- **9.1.B** Communicate and comprehend written and verbal thoughts, ideas, directions, and information relative to educational and occupational settings.
- **9.1.B** Select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.
- **9.2.A** Apply communications and data analysis to the problem-solving and decision making processes in a variety of life situations.
- **9.2.A** Apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.
- **9.2.F** Practice the safe use of tools and equipment.

**Cross Curricular:**
- Mathematics: Equations, graphs, algebra, geometry, and trigonometry are used on a daily basis to analyze the physical world around us.
- History: Prominent scientists are discussed. Their contributions to science are detailed, and they are placed in context with other concurrent world events.

**Technology:**
- **8.1.12.A.2** Produce and edit a multi-page document for a commercial or professional audience using desktop publishing and/or graphic software.

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<td>Electrostatics</td>
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Chemistry in the Community

Overview:
This version of Chemistry I places emphasis on the influence of chemistry on our lives. It is designed for students planning careers not related to science. The units of study are: water; resources; petroleum; nuclear chemistry; food; air and climate; chemistry and health; and chemical industry.

All SBHS students will develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment in alignment with the New Jersey Core Content Standards for Science.
Content: Curriculum for Chemistry in the Community

Philosophy:
We believe that science as a way of thinking is for everyone. Every educated individual needs to have science literacy and skills. This program is designed to help students achieve an understanding of chemistry concepts. It will encourage the student to look differently at the world. The student will develop the ability to use technology and sound evidence-gathering skills to support critical thinking and decision-making.

Textbook: *Chemistry in the Community*, 4ed, Freeman

<table>
<thead>
<tr>
<th>New Jersey Core Curriculum Content Standards in Science</th>
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</thead>
<tbody>
<tr>
<td>The following standards have been covered within this curriculum: 09 NJCCCS</td>
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</tbody>
</table>

5.1 **Science Practices:** All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

**A. Understand Scientific Explanations:** Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

5.1.12.A.1 Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.
5.1.12.A.2 Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
5.1.12.A.3 Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

**B. Generate Scientific Evidence Through Active Investigations:** Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

5.1.12.B.2 Mathematical tools and technology are used to gather, analyze, and communicate results.
5.1.12.B.4 Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

**C. Reflect on Scientific Knowledge:** Scientific knowledge builds on itself over time.

5.1.12.C.2 Data and refined models are used to revise predictions and explanations.

**D. Participate Productively in Science:** The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

5.1.12.D.1 Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.
5.1.12.D.2 Science involves using language, both oral and written, as a tool for making thinking public.
5.1.12.D.3 Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.
5.2 Physical Science: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

A. Properties of Matter: All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

5.2.12.A.1 Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.

5.2.12.A.2 Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.

5.2.12.A.3 In the Periodic Table, elements are arranged according to the number of protons (the atomic number). This organization illustrates commonality and patterns of physical and chemical properties among the elements.

5.2.12.A.4 In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.

5.2.12.A.5 Solids, liquids, and gases may dissolve to form solutions. When combining a solute and solvent to prepare a solution, exceeding a particular concentration of solute will lead to precipitation of the solute from the solution. Dynamic equilibrium occurs in saturated solutions. Concentration of solutions can be calculated in terms of molarity, molality, and percent by mass.

5.2.12.A.6 Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.

B. Changes in Matter: Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

5.2.12.B.1 An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.

5.2.12.B.2 A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.

5.2.12.B.3 The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept.

C. Forms of Energy: Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

5.2.12.C.1 Gas particles move independently and are far apart relative to each other. The behavior of gases can be explained by the kinetic molecular theory. The kinetic molecular theory can be used to explain the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample. There is a natural tendency for a system to move in the direction of disorder or entropy.

5.2.12.C.2 Heating increases the energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic energy of the atoms, molecules, or ions increases, the temperature
of the matter increases. Heating a pure solid increases the vibrational energy of its atoms, molecules, or ions. When the vibrational energy of the molecules of a pure substance becomes great enough, the solid melts.

D. Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

5.12.D.2 The driving forces of chemical reactions are energy and entropy. Chemical reactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).

5.12.D.5 Chemical equilibrium is a dynamic process that is significant in many systems, including biological, ecological, environmental, and geological systems. Chemical reactions occur at different rates. Factors such as temperature, mixing, concentration, particle size, and surface area affect the rates of chemical reactions.

5.3 Life Science:

B. Matter and Energy Transformations: Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

5.12.B.6 All organisms must break the high-energy chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes.

5.4 Earth Systems Science: All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe.

C. Interdependence: All animals and most plants depend on both other organisms and their environment to meet their basic needs.

5.4.C.1 Observations and investigations form a basis for young learners’ understanding of properties of Earth materials.

5.4.C.2 Soils are made of many living and nonliving substances. The attributes and properties of soil (e.g., moisture, kind and size of particles, living/organic elements, etc.) vary depending on location.

E. Energy in Earth Systems: Internal and external sources of energy drive Earth systems.

5.12.E.1 The Sun is the major external source of energy for Earth’s global energy budget.

F. Climate and Weather: Earth’s weather and climate systems are the result of complex interactions between land, ocean, ice, and atmosphere.

5.12.F.2 Climate is determined by energy transfer from the Sun at and near Earth’s surface. This energy transfer is influenced by dynamic processes, such as cloud cover and Earth’s rotation, as well as static conditions, such as proximity to mountain ranges and the ocean. Human activities, such as the burning of fossil fuels, also affect the global climate.

5.12.F.3 Earth's radiation budget varies globally, but is balanced. Earth’s hydrologic cycle is complex and varies globally, regionally, and locally.

G. Biogeochemical Cycles: The biogeochemical cycles in the Earth systems include the flow of microscopic and macroscopic resources from one reservoir in the hydrosphere, geosphere, atmosphere, or biosphere to another, are driven by Earth's internal and external sources of energy, and are impacted by human activity.
5.4.12.G.1 Natural and human-made chemicals circulate with water in the hydrologic cycle.
5.4.12.G.2 Natural ecosystems provide an array of basic functions that affect humans. These functions include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients.
5.4.12.G.4 Natural and human activities impact the cycling of matter and the flow of energy through ecosystems.
5.4.12.G.5 Human activities have changed Earth’s land, oceans, and atmosphere, as well as its populations of plant and animal species.
5.4.12.G.7 Earth is a system in which chemical elements exist in fixed amounts and move through the solid Earth, oceans, atmosphere, and living things as part of geochemical cycles.

**Enduring Understandings**

- In our society we use water both directly and indirectly.
- Transporting material to and from cells is essentially the function of water in our bodies.
- Water is constantly being recycled by the hydrologic cycle.
- Water has unique properties which make it essential for life.
- Matter can be classified as elements, compounds and mixtures.
- Matter is made of atoms which are unique for each element.
- Atoms are made of protons, neutrons and electrons. The arrangements of these particles give the elements their unique chemical and physical properties.
- Matter cannot be created or destroyed, only transformed from one form to another.
- Our Earth’s resources are limited.
- Our daily activities affect the global environment both negatively as well as positively.
- The Earth's atmosphere filters the sun's radiation allowing for life on the planet.
- Hydrocarbons are organic compounds that are useful as fuel.
- Carbon is the building block for many compounds found in fuels, plastics, flavors, fragrances and pharmaceuticals.

**Essential Questions**

- What behavior will ensure your own safety and health and that of others?
- How can water be purified?
- What are the physical and chemical properties of water?
- Why do some substances readily dissolve in water and others do not?
- How is water treated to make it safe and soft?
- How can the physical and chemical properties of matter be explained?
- Where are mineral resources found and how are they processed?
- What information do chemical equations convey about matter and its changes?
- What happens to matter during a chemical reaction?
- How can matter be modified to make it more useful?
- What is Petroleum?
- How is petroleum an energy source?
- How is petroleum a building source?
- Are there alternatives to petroleum?
- How does the composition of the Earth’s atmosphere affect its properties and behavior?
- How does solar radiation influence conditions on Earth?
- What are the major causes and consequences of acid rain?
• How can air pollution be controlled?
• How does the chemical industry transform elements and compounds into other useful materials?
• What chemical principles are involved in converting nitrogen gas to nitrogen-containing compounds?

**Student Responsibilities**

The student will…

• Work to maintain a safe environment in the classroom and lab.
• Complete reading and other assignments in a timely fashion.
• Treat members of the classroom with courtesy and respect.
• Maintain a well-organized notebook.
• Participate as an individual and as a member of a cooperative group.
• Be here to do your best and to learn.
• Communicate effectively by acquiring and using appropriate scientific vocabulary.
• Apply appropriate math skills

**Course Outline and Pacing Guide:**

Lesson #1

**Essential Question:** What behavior will ensure your own safety and health and that of others?

**Time:** 1 block

**Standards:** 09 NJCCCS  5.1.12.D.3

**Text:** Unit Section 0.0

**Objectives:**

• Be aware how common injuries can be prevented.
• Demonstrate safe physical movement.
• Demonstrate safe use of tools and equipment.
• Identify and demonstrate the use of recommended safety and protective equipment.

**Topics:**

• Lab Safety Rules
• Tour of room safety equipment
• Video Starting with Safety

**Assessments:**

• Lab Safety Quiz
• Additional Resources and Activity: Safety Contract

Lesson #2

**Essential Question:** How can water be purified?

**Time:** 5 blocks

**Standards:** 09 NJCCCS  5.1.12.A.1,  5.2.12.A.2,  5.2.12.A.5,  5.1.12.D.1,  5.4.12.G.1

**Text:** Chapter 1.A

**Objectives:** Students will be able to…

• Discuss direct and indirect water use and their importance.
• Identify techniques of water purification.
• Define function and operation of the hydrologic cycle.

**Topics:**

• A.0 Riverwood fish kill
• A.1 The initial challenge.
- A.2  Foul Water Lab
- A.3  Uses of Water
- A.4  Water Supply and Demand
- A.5  Where is Earth’s Water
- A.6  Water Use Analysis
- A.7  Riverwood Water Use

Assessments:
- ChemQuandry: Water, Water Everywhere
- Lab report w/ questions: Foul Water
- Making Decisions Water Use Analysis
- Building Skills: Water Use in the United States
- Making Decisions & ChemQuandry
- Making Decisions-Riverwood Water Use
- Summary Questions
- Quiz

Additional Resources and Activity:
- Skills Sheet: Graphing
- Skills Sheet: Use of Numbers

Lesson #3

<table>
<thead>
<tr>
<th>Essential Question: What are the physical and chemical properties of water?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time: 7 blocks</td>
</tr>
<tr>
<td>Text: Section 1.B</td>
</tr>
<tr>
<td>Objectives: Students will be able to…</td>
</tr>
<tr>
<td>- Classify matter in terms of elements, compounds, and mixtures.</td>
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<tr>
<td>- Distinguish between different types of mixtures.</td>
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<tr>
<td>- Distinguish among a chemical symbol, formula, and chemical equation.</td>
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<tr>
<td>- Describe the model of the three subatomic particles.</td>
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<tr>
<td>- Determine the name and formula of simple ionic compounds.</td>
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</tbody>
</table>

Topics:
- B.1  Physical Properties of Water
- B.2  Mixtures and Solutions
- B.3  Molecular View of Water
- B.4  Symbols, Formulas, and Equations
- B.5  The Electrical Nature of Matter
- B.6  Ions and Ionic Compounds
- B.7  Water Testing
- B.8  Pure and Impure Water
- B.9  The Riverwood Water Mystery
- B.10  What are the Possibilities

Assessments:
- Building Skills 2- Density
- Modeling Matter-Pictures in the Mind
- Building Skills 3-Working with Symbols, Formulas, and Equations
• Building Skills 4-Ionic Compounds
• Laboratory Activity-Water Testing (Confirming Tests)
• Making Decisions
• Summary Questions
• Quiz

Additional Resources and Activity:
• Video: Elements
• Skills Sheets: Chemical Equations
Lesson #4

Essential Question: Why do some substances readily dissolve in water and others do not?

Time: 5 blocks


Text: Section 1.C

Objectives: Students will be able to…

- Use solubility curves to describe the effect of temperature on solubility.
- Define insoluble, unsaturated, saturated, supersaturated, and calculate concentrations.
- Evaluate risks of contaminants in our water supply, with particular attention to heavy metals.
- Given the pH of a substance, classify it as acidic, basic, or neutral.
- Describe the solubility of a molecular substance in water.
- Use the polarity of water molecules to explain water’s ability to dissolve ionic solids.

Topics:
- C.1 Solubility of Solids
- C.2 Solution Concentration
- C.3 Construction a Solubility Curve
- C.4 Dissolving Ionic Compounds
- C.5 Heavy Metal Ions
- C.6 pH Levels
- C.7 Molecular Substances
- C.8 Solvents
- C.9 Dissolved Oxygen
- C.10 Temperature, Dissolved Oxygen, and Life
- C.11 Cause of the Fish Kill

Assessments:
- Building Skills 5-Solubility Curves
- Building Skills 6-Concentrations
- Lab Activity with Questions (Alternate Version)
- Modeling Matter-Dissolving Ionic Compounds
- Lab Activity with Questions
- Making Decisions
- Summary Questions
- Quiz

Lesson #5

Essential Question: How is water treated to make it safe and soft?

Time: 4 blocks


Text: Section 1.D

Objectives: Students will be able to…

- Compare and contrast natural and artificial water purification.
- Assess the risks and benefits of water softening and chlorination

Topics:
- D.1 Natural Water Purification
- D.2 Municipal Water Purification
- D.3 Chlorination of Water
- D.4 Chlorination and THMs
- D.5 Water Softening
- D.6 Water and Water Softening

Assessments:
- Putting It All Together-Fish Kill-Finding the Solution
- Building Skills 7-Water Purification
- Making Decisions
- ChemQuandry-Bottled Water Versus Tap Water
- Lab Activity Water Softening
- Summary Questions
- Quiz
- Town Council Meeting

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**Lesson #6**

**Essential Question:** How can the physical and chemical properties of matter be explained?

**Time:** 5 blocks

**Standards:** 09 NJCCCS 5.1.12.D.3, 5.2.12.A.2, 5.2.12.A.3, 5.2.12.A.4, 5.2.12.B.1,

**Text:** Section 2.A

**Objectives:** Students will be able to...

- Distinguish between chemical and physical properties.
- Classify selected elements as metals, nonmetals, or metalloids based on observations of chemical and physical properties.
- Use the Periodic Table to predict physical and chemical properties of an element.
- Use the Periodic Table to identify the elements by their atomic masses and atomic numbers.
- Use the Periodic Table to locate period and groups of elements.
- Determine properties of elements by the number and arrangement of the electrons in the atom.

**Topics:**
- A.1 Properties Make the Difference
- A.2 The Chemical Elements
- A.3 Metal or Nonmetal
- A.4 The Periodic Table
- A.5 Grouping the Elements
- A.6 The Pattern of Atomic Numbers
- A.7 What Determines Properties
- A.8 It’s Only Money

**Assessments:**
- Building Skills 1-Properties Make the Difference
- Lab Activity
- Making Decisions
- Building Skills 2-Periodic Variations in Properties
- Building Skills 3-Predicting Properties
- Making Decisions
### Lesson #7

**Essential Question:** Where are mineral resources found and how are they processed?

**Time:** 5 blocks

**Standards:** 09 NJCCCS 5.2.12.A.2, 5.2.12.A.3, 5.2.12.B.2, 5.4.12.C.1

**Text:** Section 2.B

**Objectives:** Students will be able to...

- Describe the three major parts of Earth.
- List and describe the factors that determine the feasibility of mining a particular ore at a particular site.
- Explain why more active metals are more difficult to refine and process than less active metals.
- Describe the process of oxidation-reduction.
- Describe the three most common methods of separating a metal from its ore.

**Topics:**
- B.1 Sources and Uses of Metals
- B.2 Converting Copper
- B.3 Metal Reactivity
- B.4 Relative Metal Reactivity
- B.5 Metals: Properties and Uses
- B.6 Mining and Refining

**Assessments:**
- Building Skills 4
- Lab Activity (Alternate Version Available: Edition 2)
- Lab Activity
- ChemQuandry
- Building Skills 5-Trends in Metal Activities
- Modeling Matter-Redox Process
- Summary Questions
- Quiz

**Additional Resources and Activity:**
- Video Tape *Chemical Reactions*

### Lesson #8

**Essential Question:** What information do chemical equations convey about matter and its changes?

**Time:** 8 blocks

**Standards:** 09 NJCCCS 5.2.12.B.3, 5.2.12.B.1, 5.4.12.G.4

**Text:** Sections 2.C

**Objectives:** Students will be able to...

- State the Law of Conservation of Matter and apply the law by balancing chemical equations.
- Write balanced equations and relate them to the Law of Conservation of Matter.
- Define the term mole and calculate the molar mass of a compound.
- Calculate percent composition by mass.
- Distinguish between renewable and nonrenewable resources.
- Identify the methods of conserving our resources.

**Topics:**
- C.1 Keeping Track of Atoms
- C.2 Nature’s Conservation: Balanced Chemical Equations
- C.3 Atom, Molecule, and Ion Inventory
- C.4 Composition of Material
- C.5 Retrieving Copper
- C.6 Conservation in the Community
- C.7 The Life Cycle of a Material
- C.8 Designing a Coin

**Assessments:**
- Building Skills 6-Accounting for Atoms
- Building Skills 7-Writing Chemical Equations
- Building Skills 8-Molar Mass
- Building Skills 9-Percent Composition
- Lab Activity
- Building Skills 10-Copper Life Cycle
- Making Decisions
- Summary Questions
- Quiz

**Additional Resources:**
- Video: Statue of Liberty
- Video: World of Chemistry-The Mole

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**Lesson #9**

**Essential Question:** How can matter be modified to make it more useful?

**Time:** 4 blocks  
**Standards:** 09NJCCCS 5.2.12.A.2

**Text:** Sections 2D

**Objectives:** Students will be able to...

- Describe the difference in the properties of an element due to the arrangement of the element’s atoms.
- Describe the difference between the properties of an element and the properties of its alloys.
- Describe how the conductivity of a material can be changed.
- Describe how the properties of a material may be changed by applying a coating.

**Topics:**
- D.1 Structure and Properties: Allotropes
- D.2 Modifying Properties
- D.3 Striking It Rich
- D.4 Combinations of Elements, Alloys, and Semiconductors
- D.5 Modifying Surfaces
### Assessments:
- ChemQuandry 2
- Building Skills 11-Linking Properties to Structure
- Building Skills 12-Alternatives to Metals
- Lab Activity
- ChemQuandry 3
- Lab Activity
- Summary Questions
- Quiz

### Additional Resources and Activity:
- Video: *Inside the US mint*

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**Lesson #10**

**Essential Question:** What is Petroleum?

**Time:** 6 blocks

**Standards:** 09NJCCCS 5.2.12.D.2, 5.2.12.C.2, 5.2.12.D.2

**Text:** Section 3.A

**Objectives:** Students will be able to…

- Describe the chemical makeup of petroleum, how it differs from other natural resources, and how
- Describe the process of fractional distillation and name the typical products manufactured from each fraction.
- Represent the covalent bonding in hydrogen bonding by electron-dot, structural, and molecular formulas.
- Write the general formulas for the first ten alkanes.
- Define the term isomer and draw the structural formulas for the first three isomers of a given compound.

**Topics:**

- A.1 What is Petroleum?
- A.2 Separation by Distillation
- A.3 Petroleum Refining
- A.4 A Look at Petroleum’s Molecules
- A.5 Chemical Bonding
- A.6 Modeling Alkanes
- A.7 Alkanes Revisited

**Assessments:**

- Who Has It? Who Uses It?
- Lab Activity done as demo
- Building Skills 1-Hydrocarbon Boiling Points
- Lab Activity- Alkane modeling
- Building Skills 2-Trends in Alkane Boiling Points
- Lab Activity- Alkanes Revisited
- Building Skills 3-Boiling Points of Alkane Isomers
- Summary Questions
- Quiz
Lesson #11

**Essential Question:** How is petroleum an energy source?

**Time:** 4 blocks

**Standards:** 09 NJCCCS 5.2.12.D.2, 5.3.12.B.6, 5.4.12.E.1

**Text:** Section 3.B

**Objectives:**
- Explain endothermic and exothermic reactions in terms of bond breaking and bond forming.
- Identify energy conversions and explain energy conversion efficiency.
- Define heat of combustion and specific heat and calculate energies of various combustion reactions.
- Write balanced equation for the combustion of hydrocarbon fuels, including energy changes.
- Explain the term octane number, state its relationship to grades of gasoline, and identify two ways of increasing octane numbers.

**Topics:**
- B.1 Energy and Fossil Fuels
- B.2 Energy Conservation
- B.3 Combustion
- B.4 Using Heats of Combustion
- B.5 Altering Fuels
- B.6 Fuel Molecules in Transportation

**Assessments:**
- ChemQuandry 1
- Building Skills 4-Wasted Energy
- Building Skills 5 Energy Conversion Efficiency
- Lab Activity- Heats of Combustion
- Building Skills 6-Heats of Combustion
- ChemQuandry 2
- Making Decisions
- Summary Questions
- Quiz

**Additional Resources and Activity:**
- Video: Fuel Less
- Video: Carbon

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Lesson #12

**Essential Question:** How is petroleum a building source?

**Time:** 4 blocks

**Standards:** 09 NJCCCS 5.2.12.A.2, 5.2.12.A.1

**Text:** Section 3.C

**Objectives:** Students will be able to...
- Compare saturated and unsaturated hydrocarbons in terms of molecular models, formulas, structures, and physical and chemical properties.
- Identify the functional groups for common alcohols, ethers, carboxylic acids, and esters.
- Describe polymerization and give one example of addition and condensation reactions.

### Topics:
- C.1 Creating New Options: Petrochemicals
- C.2 Beyond Alkanes
- C.3 The Builders
- C.4 More Builder Molecules
- C.5 Builder Molecules Containing Oxygen
- C.6 Condensation Polymers
- C.7 Condensation
- C.8 Builder Molecules in Transportation

### Assessments:
- Modeling Matter
- Lab Activity- Polymers
- Lab Activity- Aldehydes
- Making Decisions
- Summary Questions
- Quiz

### Additional Resources and Activity:
- Video: World of Chemistry-Carbon
- Video: World of Chemistry-Polymers

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Lesson #13

**Essential Question:** Are there alternatives to petroleum?

**Time:** 3 blocks  
**Standards:** 09NJCCCS 5.2.8.C.2, 5.2.12.D.2  
**Text:** Section 3.D

**Objectives:** Students will be able to…
- Describe major sources of energy and alternative sources of fuels and builder molecules for the future.
- Describe alternative fuels that may be used to extend, supplement, or replace petroleum as Earth’s primary fuel.

**Topics:**
- D.1 Energy: Past, Present, and Future
- D.2 Alternative Energy Sources
- D.3 Alternative-Fuel Vehicles

**Assessments:**
- Building Skills 8-Fuel Sources Over the Years
- Summary Questions
- Quiz

**Additional Resources and Activity:**
- Tie Dye Lab

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Lesson #14
Essential Question: How does the composition of the Earth’s atmosphere affect its properties and behavior?

Time: 5 blocks
Text: Section 4.A

Objectives: Students will know that…

- Earth’s atmosphere is composed of a mixture of gases, primarily nitrogen, oxygen, and water vapor.
- Pressure involves a force applied over a particular area. Area is often measured in units of atmosphere, pascals, or millimeters of mercury.
- The volume of a sample of gas in a flexible container decreased if the external pressure increases (Boyle's Law).
- The volume of a sample of gas in a flexible container at constant pressure increases if its temperature is increased and decreases if its temperature decreases (Charles Law).
- The pressure exerted by a sample of gas in a rigid container increases if its temperature is increased and decreases if its temperature is decreased.

Topics:
- A.1 Exploring Properties of Gases
- A.2 Structure of the Atmosphere
- A.3 Pressure
- A.4 Atoms and Molecules in Motion
- A.5 Boyle’s Law-P-V Relationships
- A.6 Temperature-Volume Relationships
- A.7 Charles’ Law
- A.8 Temperature-Pressure Relationships
- A.9 Ideal Gases and Molar Volume

Assessments:
- Lab Activity
- Building Skills 1-Graphing Atmospheric Data
- Building Skills 2-Applications of Pressure
- Building Skills 3-P-V Relationships
- Lab Activity as demo
- Building Skills 4-T-V Relationships
- Building Skills 5-Temperature-Pressure Relationships
- Modeling Matter
- Building Skills 6-Molar Volume and Reactions
- Summary Questions
- Quiz

Additional Resources and Activity:
- Video: Earth Day
- Video: World of Chemistry-Gas Storage
- Video: Color
- Activity-Hot Air Balloons

Lesson #15

Essential Question: How does solar radiation influence conditions on Earth?
### Lesson #16

**Essential Question:** What are the major causes and consequences of acid rain?

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Text: Sections 4.C</td>
<td>Objectives: Students will know that…</td>
</tr>
<tr>
<td></td>
<td>• Rainwater is naturally acidic, but contaminants in the atmosphere can produce precipitation that is even more acidic than normal.</td>
</tr>
<tr>
<td></td>
<td>• Sulfur oxides and nitrogen oxides generated from natural and human sources contribute to acid rain.</td>
</tr>
<tr>
<td></td>
<td>• Acids produce hydrogen ions in water, while bases produce hydroxide ions. Strong acids and bases ionize completely; weak acids and bases ionize only partially.</td>
</tr>
<tr>
<td></td>
<td>• pH is a measure of the molar concentration of hydrogen ions in a solution. Solutions with pH 7 at room temperature are neutral, while those with a lower pH are acidic and those with a higher</td>
</tr>
</tbody>
</table>

---

### Objectives: Students will know that…

- Electromagnetic radiation includes x-rays, gamma rays, ultraviolet light, visible and infrared radiation, radio waves and microwaves.
- Earth’s atmosphere protects living organisms by absorbing and distributing solar energy.
- Electromagnetic radiation can interact with matter to transfer energy.

### Topics:

- **B.1 Solar Radiation**
- **B.2 Earth’s Energy Balance**
- **B.3 At Earth’s Surface**
- **B.4 Specific Heat Capacity**
- **B.5 The Carbon Cycle**
- **B.6 Carbon Dioxide Levels**
- **B.7 Greenhouse Gases and Global Change**
- **B.8 Planning for Greenhouse Gases**

### Assessments:

- ChemQuandry 1
- Building Skills 7-Solar Radiation
- ChemQuandry 2
- Building Skills 8-Thermal Properties of Materials
- Lab Activity
- Modeling Matter
- Building Skills 9-Trends in CO2 Levels
- Making Decisions
- Summary Questions
- Quiz

### Additional Resources and Activity:

- Video: Greenhouse Effect
- Video: Infinite Voyage
pH are basic.
- Acid precipitation can lower the pH of lakes and streams, which can adversely affect aquatic life.
- A buffered solution is capable of neutralizing limited amounts of either an acid or base, thus resisting changes in pH.

Topics:
- C.1 Acid Rain
- C.2 Making Acid Rain
- C.3 Preventing Acid Rain
- C.4 Structure Determines Function
- C.5 pH and Acidity
- C.6 Strengths of Acids and Bases
- C.7 Acids, Bases, and Buffers
- C.8 Buffers
- C.9 Lunar Habitation

Assessments:
- Lab Activity
- Making Decisions
- Building Skills 10-Acids and Bases
- Building Skills 11-pH
- Modeling Matter
- Lab Activity
- Making Decisions
- Summary Questions
- Quiz

Lesson #17

Essential Question: How can air pollution be controlled?

Time: 3 blocks
Text: Section 4.D

Objectives: Students will know that…
- Air pollution is a result of contributions from both primary and secondary sources.
- Photochemical smog can intensify due to temperature inversions and adverse wind patterns.
- Chlorofluorocarbons can destroy stratosphere ozone.

Topics:
- D.1 Sources of Air Pollution
- D.2 Identifying Major Air Contaminants
- D.3 Smog: Hazardous to Your Health
- D.4 Vehicles and Smog
- D.5 Pollution Control and Prevention
- D.6 Cleaning Air
- D.7 Controlling Automobile Emissions
- D.8 Ozone and CFCs: A Success Story
Assessments:
- Making Decisions
- ChemQuandry 3-Limiting Reactants and Scrubbers
- Lab Activity
- ChemQuandry 4-Controlling Air Pollution
- Summary Questions
- Quiz

Additional Resources and Activity:
- Video: Crisis in the Atmosphere

### 21st-Century Connections

#### Standard 9.1 21st-Century Life & Career Skills:
All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

#### Cross Curricular
- History:
  The function and structure of local governments.
  The historical development of metals and other resources moving through the bronze/copper age to the iron/steel age.
  The development of the periodic table.
  The rise of petroleum as the major energy source in the world.
- Mathematics, using Mathematical tools to:
  Do calculations e.g. molar mass → percent composition
  Analyze data e.g. graphing → to show trends and make predictions.
  Balance and write chemical equations

#### Character Education
- Honesty:
  Students are expected to adhere to the integrity code of the high school.
  Students are expected to give honest effort on all assignments.
- Respect:
  Students are expected to treat all members of the classroom with courtesy and respect.
- Service:
  Students are expected to maintain a safe and clean environment in the classroom and the lab.
- Responsibility:
  Students are expected to take responsibility for their own actions.
Students are expected to do their best and learn.

**Career**

As per the NJCCCS

9.1.B
- Students will communicate and comprehend written and verbal thoughts, ideas, directions, and information relative to educational and occupational settings.
- Students will select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.

9.2.A
- Students will apply communications and data analysis to the problem-solving and decision making processes in a variety of life situations.
- Students will apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.

9.2.C
- Students will model interpersonal and effective conflict resolution skills.
- Students will communicate effectively in a variety of settings with a diverse group of people.

9.2.D
- Discuss consequences and sanctions when on-the-job rules and laws are not followed.

9.2.F
- Engage in an informed discussion about rules and laws designed to promote safety and health.
- Describe and demonstrate basic first aid and safety procedures.
- Practice the safe use of tools and equipment.
- Implement safety procedures in the classroom and workplace, where appropriate.

**Technology**

As per the NJCCCS

8.1.12.A.2
Produce and edit a multi-page document for a commercial or professional audience using desktop publishing and/or graphics software.

8.2.12.C.2
Evaluate ethical considerations regarding the sustainability of resources that are used for the design, creation, and maintenance of a chosen product.
Overview:

This version of Chemistry is designed for students who have an interest in science and prepares a student for the study of chemistry at the college level.

All SBHS students will develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment in alignment with New Jersey Core Content Standards for Science.
Content: Chemistry I Traditional

Philosophy:
We believe that science as a way of thinking is for everyone. Every educated individual needs to have science literacy and skills. This program is designed to help students achieve an understanding of chemistry concepts. It will encourage the student to look differently at the world. The student will develop the ability to use technology and sound evidence-gathering skills to support critical thinking and decision-making.

Textbook: Chemistry (Prentice Hall) – Wilbraham, Staley, Matta, Waterman (2005)

<table>
<thead>
<tr>
<th>New Jersey Core Curriculum Content Standards For Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following standards have been covered within this curriculum: 09 NJCCCS</td>
</tr>
</tbody>
</table>

5.1 Science Practices: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

A. Understand Scientific Explanations: Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.
   - 5.1.12.A.1 Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.
   - 5.1.12.A.2 Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
   - 5.1.12.A.3 Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

B. Generate Scientific Evidence Through Active Investigations: Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.
   - 5.1.12.B.1 Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
   - 5.1.12.B.2 Mathematical tools and technology are used to gather, analyze, and communicate results.
   - 5.1.12.B.3 Empirical evidence is used to construct and defend arguments.
   - 5.1.12.B.4 Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

C. Reflect on Scientific Knowledge: Scientific knowledge builds on itself over time.
   - 5.1.12.C.1 Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
   - 5.1.12.C.2 Data and refined models are used to revise predictions and explanations.
   - 5.1.12.C.3 Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.
D. Participate Productively in Science: The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

- **5.1.12.D.1** Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.
- **5.1.12.D.2** Science involves using language, both oral and written, as a tool for making thinking public.
- **5.1.12.D.3** Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.

5.2 Physical Science: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

A. Properties of Matter: All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

- **5.2.12.A.1** Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.
- **5.2.12.A.2** Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.
- **5.2.12.A.3** In the Periodic Table, elements are arranged according to the number of protons (the atomic number). This organization illustrates commonality and patterns of physical and chemical properties among the elements.
- **5.2.12.A.4** In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.
- **5.2.12.A.5** Solids, liquids, and gases may dissolve to form solutions. When combining a solute and solvent to prepare a solution, exceeding a particular concentration of solute will lead to precipitation of the solute from the solution. Dynamic equilibrium occurs in saturated solutions. Concentration of solutions can be calculated in terms of molarity, molality, and percent by mass.
- **5.2.12.A.6** Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.

B. Changes in Matter: Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

- **5.2.12.B.1** An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.
- **5.2.12.B.2** A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.
- **5.2.12.B.3** The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept.
C. Forms of Energy: Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

5.2.12.C.1 Gas particles move independently and are far apart relative to each other. The behavior of gases can be explained by the kinetic molecular theory. The kinetic molecular theory can be used to explain the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample.

There is a natural tendency for a system to move in the direction of disorder or entropy.

5.2.12.C.2 Heating increases the energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic energy of the atoms, molecules, or ions increases, the temperature of the matter increases.

Heating a pure solid increases the vibrational energy of its atoms, molecules, or ions. When the vibrational energy of the molecules of a pure substance becomes great enough, the solid melts.

D. Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

5.2.12.D.2 The driving forces of chemical reactions are energy and entropy. Chemical reactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).

5.2.12.D.3 Nuclear reactions (fission and fusion) convert very small amounts of matter into energy.

5.2.12.D.4 Energy may be transferred from one object to another during collisions.

5.2.12.D.5 Chemical equilibrium is a dynamic process that is significant in many systems, including biological, ecological, environmental, and geological systems. Chemical reactions occur at different rates. Factors such as temperature, mixing, concentration, particle size, and surface area affect the rates of chemical reactions.

Enduring Understandings

Chemistry
Chemistry is essential to understand the physical and biological world.

Lab Safety
Potential hazards are mitigated by following directions and careful technique.

Scientific Method
The scientific method is a databased logical approach to problem solving.

Metric System
The metric system is a worldwide measurement system based on powers of ten.

Percent Error
Precision of measurement and lab technique influence the relative (percent) error.

Dimensional Analysis
Dimensional analysis is a unit-based logical approach to problem solving.

Significant Figures
Significant figures limit the degree of reportable precision and the validity of results.
<table>
<thead>
<tr>
<th>Scientific Notation</th>
<th>Very large and very small numbers can be written concisely using powers of 10.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>Accuracy and precision and units are important to achieve correct results.</td>
</tr>
<tr>
<td>Types of Matter</td>
<td>Differences between elements, compounds and mixtures.</td>
</tr>
<tr>
<td>Symbols, Names &amp; Formulas</td>
<td>Communication has been established by the use of symbol and nomenclature systems to make the understanding of chemistry uniform among scientists.</td>
</tr>
<tr>
<td>Properties</td>
<td>Intensive are substance specific and extensive depend on the size of the sample.</td>
</tr>
<tr>
<td>Periodic Table</td>
<td>The periodic table reveals patterns and relationships between atoms and elements. These relationships can be explained by examining subatomic arrangements of particles.</td>
</tr>
<tr>
<td>Atomic Theory</td>
<td>The atomic theory is evolving to explain past as well as current experimental results.</td>
</tr>
<tr>
<td>The Mole</td>
<td>The mole is an essential concept to understanding the mechanisms of chemistry.</td>
</tr>
<tr>
<td>Conservation of Mass</td>
<td>The amount of matter in the universe is essentially constant. It is only rearranged.</td>
</tr>
<tr>
<td>Stoichiometry</td>
<td>Role of the mole in chemical calculations, and application of dimensional analysis in their solutions.</td>
</tr>
<tr>
<td>States of Matter</td>
<td>The phases of matter are determined by the proximity of molecules and energy involved in their changes.</td>
</tr>
<tr>
<td>Thermochemistry</td>
<td>Energy is transferred in chemical and physical reactions.</td>
</tr>
<tr>
<td>Gas Laws</td>
<td>Pressure, temperature, number of particles, and volume are interrelated. Behavior of gases is governed by equations called &quot;gas laws.&quot;</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>Energy and randomness are the two driving forces of change.</td>
</tr>
<tr>
<td>Kinetics</td>
<td>The importance of molecular collision frequency in rates of chemical reactions. A successful collision requires proper orientation of particles and sufficient energy.</td>
</tr>
<tr>
<td>Equilibrium</td>
<td>Some reactions can occur both forward and backward, at the same rate. An equilibrium system will respond to stress; shift and find a new balance. Experimental conditions can influence the amount of a substance produced in an equilibrium reaction.</td>
</tr>
<tr>
<td>Acid-Base</td>
<td>Acids and bases are chemical opposites and can neutralize each other. pH is a logarithmic scale that describes the concentration of H+ ions.</td>
</tr>
</tbody>
</table>
### Redox
Oxidation and reduction are opposite reactions and always occur together. Applied electricity can be used to force non-spontaneous reactions to occur. Spontaneous redox reactions can be used to produce electricity.

### Bonding
The types of bonds a substance has influences its chemical and physical properties. Electron arrangement in a molecule can be used to predict molecular shapes.

### Organic Chemistry
Organic compounds contain one or more of the following elements: O, H, N, S, P. Isomers are differing arrangements of the same atoms. Functional groups determine chemical properties of organic substances. One set of naming rules is used for a vast number of organic molecules. Functional groups present can be used to predict products of an organic reaction.

### Environmental Chemistry
Industrialization has resulted in contaminating air, water and soil. Careful management of industrial and agricultural processes can prevent pollution.

### Essential Questions:
- How should we behave in the lab?
- How are formulas written and chemicals named?
- How many atoms are in a sample?
- How are chemical reactions represented?
- How are the quantities of substances involved in chemical reactions calculated?
- What is inside the atom?
- How are the electrons arranged?
- How is the information about the elements organized?
- What are some common properties of the elements?
- What is heat?
- How are molecules held together?
- What are their shapes?
- What causes molecular motion and how is it measured?
- How are gases and the mole concept related?
- How do gases behave? How do various conditions change the characteristics of the gases?
- How do certain factors affect the rate of a reaction?
- How do changes affect reversible reactions?
- How do acids, bases and salts behave?
- How can the concentration of an acid or bases be determined?
### Course Outline and Pacing Guide:

#### Lesson #1: Introduction

**Essential Question:** How should we behave in the lab?

**Time:** 2 Blocks

**Standards:** 09 NJCCCS 5.1.12.D.3, 5.1.12.A,B,C,D

**Objectives:** SWBAT demonstrate safe behavior in the lab

**Topic:** Safe behavior

**Assessment:** Video tape- Starting with safety; review of safety rules; safety quiz

#### Lesson #2:

**Essential Question:** How are formulas written and chemicals named?

**Time:** 5 blocks

**Standards:** 09 NJCCCS 5.2.12.B.1, 5.2.12.B.2

**Text:** Chapter 9

**Objectives:** SWBAT

- Demonstrate proficiency in writing chemical formulas.
- Define oxidation number and state oxidation numbers for common monatomic ions and charges for polyatomic ions
- Demonstrate proficiency in naming chemical compounds.
- Distinguish between molecular and empirical formulas.
- Demonstrate the use of coefficients to represent the number of formula units of a substance.
- Distinguish between and explain law of definite proportions and law of multiple proportions

**Topics:**

- Names of Elements
- Chemical Formulas & Oxidation Number
- Diatomic Molecules
- Names & Formulas of Binary Inorganic Compounds
- Molecular Compounds
- Variable Oxidation State Compounds
- Law of Definite Proportions
- Law of Multiple Proportions

**Assessments:**

- Puzzle
- Lab Formulas and Oxidation Numbers
- Quiz
- Text: p266 #17-19; p270 #22-24; p273 #29-32; p281 #47, 51, 53, 57, 58, 60, 61, 62, 63, 65-70, 74, 82, 83
- Vocabulary 9; group work p282 #65-70
- Chapter 9 test

#### Lesson #3

**Essential Question:** How many atoms are in a sample?

**Time:** 9 blocks

**Standards:** 09 NJCCCS 5.2.12.B.3, 5.1.12.B.1

**Text:** Chapter 3 (3.1, 3.2, 3.3), Chapter 10, Chapter 16.2

**Objectives:** SWBAT
- Use the factor-label method in calculations.
- Use scientific notation to express and evaluate large and small measurements.
- Use the Avogadro constant to define the mole and to calculate molecular and molar mass.
- Use the molar mass to calculate molarity of solutions, percentage composition, and empirical formulas.

Topics:
- Metric Conversions, Factor Label method
- Scientific Notation
- Molecular & Formula Mass
- Molarity
- % Composition
- Empirical Formula
- Molecular Formula

Assessments:
- On an as needed basis
- Text p96 #57-73; p315 #47-69; p499 #50-55
- Lab Peas & Rice
- Video tape “The Mole”, Demo Mole Jars, Lab Moles, Moles, Moles; # 32-41, 90-94, quiz
- Demo Stuffed moles in a Liter
- Dimensional Analysis Quick Lab p87
- Lab Size of a Molecule
- Lab Making a solution p497
- Chapter Test

Lesson #4

<table>
<thead>
<tr>
<th>Essential Question: How are chemical reactions represented? How are the quantities of substances involved in chemical reactions calculated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time: 9 blocks</td>
</tr>
<tr>
<td>Text: Chapter 11, Chapter 12</td>
</tr>
<tr>
<td>Objectives: SWBAT</td>
</tr>
<tr>
<td>- Write chemical equations to represent reactions.</td>
</tr>
<tr>
<td>- Use coefficients to balance chemical equations.</td>
</tr>
<tr>
<td>- Differentiate among five general types of chemical reactions.</td>
</tr>
<tr>
<td>- Determine the mass of a reactant or product based on the mass of another reactant or product in a reaction.</td>
</tr>
<tr>
<td>- Calculate the actual yield of a product as percentage of the theoretical yield.</td>
</tr>
</tbody>
</table>

Topics:
- Write chemical equations
- Balance chemical equations
- Types of chemical reactions
- Stoichiometry
- Actual yield & theoretical yield

Assessments:
- Text p350 #36-55; p379 #36-48
- Demonstration Types of Chemical Reactions
<table>
<thead>
<tr>
<th>Lesson #5</th>
<th>Lesson #6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Essential Question:</strong> What is inside the atom?</td>
<td><strong>Essential Question:</strong> How are electrons arranged?</td>
</tr>
<tr>
<td><strong>Time:</strong> 3 blocks</td>
<td><strong>Time:</strong> 6 blocks</td>
</tr>
<tr>
<td><strong>Standards:</strong> 09 NJCCCS 5.2.12.A.4, 5.2.12.A.1</td>
<td><strong>Standards:</strong> 09 NJCCCS 5.1.12.A.1, 5.2.12.B.1, 5.2.12.A.4</td>
</tr>
<tr>
<td><strong>Text:</strong> Chapter 4</td>
<td><strong>Text:</strong> Chapter 5</td>
</tr>
<tr>
<td><strong>Objectives:</strong> SWBAT</td>
<td><strong>Objectives:</strong> SWBAT</td>
</tr>
<tr>
<td>- Determine atomic number (Z) and mass number (A) of given isotopes of elements.</td>
<td></td>
</tr>
<tr>
<td>- Differentiate among the major subatomic particles.</td>
<td></td>
</tr>
<tr>
<td>- Calculate the average atomic mass of a mixture of isotopes of an element.</td>
<td>- Describe the wave mechanical view of the hydrogen atom</td>
</tr>
<tr>
<td>- Describe the electron cloud of the hydrogen atom.</td>
<td></td>
</tr>
<tr>
<td>- Characterize the position and velocity of an electron in an atom.</td>
<td></td>
</tr>
<tr>
<td>- Describe an electron cloud.</td>
<td></td>
</tr>
<tr>
<td>- Characterize the four quantum numbers.</td>
<td></td>
</tr>
<tr>
<td>- Use the Pauli exclusion principle and quantum numbers to describe an electron in an atom.</td>
<td></td>
</tr>
<tr>
<td>- Determine the electron configurations of the elements.</td>
<td></td>
</tr>
<tr>
<td>- Write electron dot diagrams for the elements.</td>
<td></td>
</tr>
<tr>
<td><strong>Topics:</strong></td>
<td><strong>Topics:</strong></td>
</tr>
<tr>
<td>- Determine atomic and mass number of given isotopes of elements</td>
<td></td>
</tr>
<tr>
<td>- Subatomic particles</td>
<td></td>
</tr>
<tr>
<td>- Average atomic mass</td>
<td>- Wave mechanical view</td>
</tr>
<tr>
<td></td>
<td>- Position and velocity of an electron</td>
</tr>
<tr>
<td></td>
<td>- Quantum numbers &amp; the Pauli exclusion principle</td>
</tr>
<tr>
<td></td>
<td>- Electron configurations</td>
</tr>
</tbody>
</table>

**Assessments:**
- Videotape “The Atom”,
- Text p122 #34-57
- Lab - Emission Spectroscopy
- Lab, p120 Atomic Mass of Candium
- Quiz
- Electron dot diagrams

**Assessments:**
- Text p149 #22-49, p150 #50, 57, 63, 64
- Demo- Discharge Tubes
- Quantum Number Quiz
- Vocabulary 5
- Chapter Test

**Lesson #7**

**Essential Question:** How is the information about the elements organized? What are some common properties of the elements?

**Time:** 4 blocks

**Standards:** 09 NJCCCS 5.2.12.A.3, 5.2.12.A.1

**Text:** Chapters 6

**Objectives:** SWBAT
- Use the periodic table to predict the electron configurations of elements.
- Explain the basis for the arrangement of the modern periodic table.
- Identify metals, nonmetals, and metalloids on the periodic table.
- Gives examples of relationship between an elements electron configuration and its placement on the periodic table.
- Predict the chemical stability of atoms using the octet rule.
- Use examples to explain the periodic properties of elements.
- State how atomic and ionic sizes change in groups and periods.
- Define ionization energy and electron affinity, and describe the factors that affect these properties.
- Use multiple ionization energies to predict oxidation numbers of elements.

**Topics:**
- Predict the electron configurations of elements
- Arrangement of the periodic table
- Metals, nonmetals, and metalloids
- Relationship between an elements electron configuration and its placement on the periodic table.
- Chemical stability
- Atomic and ionic sizes
- Ionization energy and electron affinity
- Oxidation numbers

**Assessments:**
- Lab p179 Periodicity in three dimensions
- Quick lab p175 Periodic trends in ionic radii
- Assessed in the review
- Sections of Video Tape #133, The Periodic Law Lab
- Chapter 6 Vocabulary; p181 #24-46; p182 #52, 55, 58, 59
- Chapter test
Lesson #8

**Essential Question:** What is heat?

**Time:** 4 blocks


**Text:** Chapter 17.1

**Objectives:** SWBAT

- Describe conditions under which heat is transferred.
- Convert between units used to measure energy.
- Describe endothermic and exothermic processes and state the function of activation energy.
- Perform calculations involving specific heat.

**Topics:**

- Conditions under which heat is transferred
- Units used to measure energy
- Endothermic and exothermic processes
- Specific heat calculations

**Assessments:**

- Text p510 #9-11, p535 #38-47
- Demo cold or hot pack, Critical Thinking Xerox
- Lab Specific Heat
- Demonstration Heat vs. Temperature
- Quiz

Lesson #9

**Essential Question:** How are molecules held together? What are their shapes?

**Time:** 3 blocks

**Standards:** 09 NJCCCS 5.2.12.B.1, 5.2.12.B.2, 5.1.12.A.2

**Text:** Chapter 7, Chapter 8

**Objectives:** SWBAT

- Identify the type of bonding between two elements given their electronegativities.
- Differentiate among properties of ionic, covalent and metallic bonds.
- Use models to explain the structure of given organic and inorganic molecules.
- Define, explain and give examples of isomerism.

**Topics:**

- Electronegativities
- Properties of ionic, covalent and metallic bonds
- Models
- Isomers

**Assessments:**

- Chemical Industry Dyes; Lab #12- Conductivity to Predict Bonding
- Video tape- #9 Molecular Architecture; Buckyballs;
- Lab - Molecular Geometry
- Text p207 #30-51, p208 #53, 61, 63, 67
- Text p247 #39-61, p248 #67, 68, 69
- Quiz

Lesson #10
## Essential Question: What causes molecular motion and how is it measured?

**Time:** 3 blocks  
**Standards:** 09 NJCCCS 5.2.12.C.1, 5.2.12.C.2, 5.2.12.A.2  
**Text:** Chapter 13  
**Objectives:** SWBAT

- List and explain the basic assumptions of the kinetic theory.  
- Relate pressure to molecular motion.  
- Differentiate an open-arm manometer, a closed-arm manometer, and a barometer.  
- Calculate the pressure of gases in both open-arm and closed-arm manometers using appropriate units.  
- Relate temperature and energy transfer to molecular motion.  
- Determine the relative velocities of gas molecules at the same temperature.  
- Describe characteristics of substances in each of the three common states of matter in terms of the kinetic theory and bonding in the substances.

**Topics:**  
- The kinetic theory  
- Pressure & molecular motion  
- Manometers  
- Temperature, energy transfer and molecular motion  
- Velocities of gas molecules and bonding

**Assessments:**  
- Video tapes The Precious Envelope (Annenburg #17) or The Greenhouse Effect; p.382 #5  
- # 6, Demos-Can Crush & Eshed Strength of Atmosphere; ChemActivity 15  
- Demo Eshed #600130 Manometer  
- Text p407 #26-49  
- Lab Sublimation p402  
- Vocabulary 13  
- Test chapter 13

---

## Lesson #11

**Essential Question:** How are gases and the mole concept related?  
**Time:** 2 blocks  
**Standards:** 09 NJCCCS 5.2.12.C.1, 5.2.12.C.2, 5.2.12.A.2, 5.2.12.B.3, 5.1.12.C.1  
**Text:** Chapter 14.3  
**Objectives:** SWBAT

- State Avogadro’s principle.  
- Define molar volume.  
- Explain and use the ideal gas equation.  
- Compute the molecular mass of a gas form its mass, temperature, pressure, and volume.

**Topics:**  
- Avogadro’s principle  
- Molar volume  
- The ideal gas equation  
- Molecular mass of a gas
### Lesson #12

**Essential Question:** How do gases behave? How do various conditions change the characteristics of the gases?

**Time:** 5 blocks  
**Standards:** 09 NJCCCS 5.2.12.C.1, 5.2.12.C.2, 5.2.12.A.2  
**Text:** Chapter 14.1, 14.2

**Objectives:** SWBAT

- Describe the conditions of STP.  
- Relate the laws of Boyle, Dalton, and Charles and perform calculations using these laws.  
- Solve problems involving the change of more than one condition for gases.

**Topics:**  
- STP  
- Boyle, Dalton, and Charles  
- Combined Gas Law

**Assessments:**  
- Class discussion of reading.  
- Transparency 39, Demo- vacuum pump; Eshed demo # 600250 – The Expansion of Gases; Soda can crush activity; p. 456 #1-9; p. 471 #26-29, 36-41  
- Text p439 #39-52  
- Test Ch 14

### Lesson #13

**Essential Question:** How do certain factors affect the rate of a reaction? How do changes affect reversible reactions?

**Time:** 8 blocks  
**Standards:** 09 NJCCCS 5.2.12.D.5, 5.2.12.B.2, 5.2.12.A.5,  
**Text:** Chapter 18.1, 18.2, 18.3, 18.5

**Objectives:** SWBAT

- List and describe the factors that influence the rate of reaction.  
- Distinguish between catalyst and inhibitor.  
- Describe and determine reaction mechanisms for simple reactions.  
- Determine the equilibrium constant expression for a system at equilibrium.  
- Use Le Chatelier’s Principle to explain the effects of changes in concentration, pressure, and temperature on an equilibrium system.  
- Relate relative amounts of product and reactant to the equilibrium constant.  
- Calculate equilibrium constants and concentrations of reactants or products for a reaction.

**Topics:**  
- Factors that affect the rate of reaction  
- Catalyst and inhibitor  
- Reaction mechanisms  
- The equilibrium constant & Le Chatelier’s Principle
Lesson #14

**Essential Question:** How do acids, bases and salts behave? How can the concentration of an acid or bases be determined?

**Time:** 11 blocks

**Standard:** 09 NJCCCS 5.2.12.A.6, 5.2.12.A.5

**Text:** Chapter 19

**Objectives:** SWBAT

- Distinguish the definitions of acids and bases and outlined in the theories of Arrhenius, Bronsted-Lowry,
- Define acidic and basic anhydrides and write formulas for them.
- Define and give examples of strong and weak acids and bases.
- Explain the concepts of neutralization and the composition of a salt and be able to name salts.
- Explain how the pH scale is used for measuring solution aciidity.
- State the principles and uses of indicators.
- Explain the process of titration and perform calculations using the data from titrations.

**Topics:**
- Arrhenius, Bronsted Lowry,
- Acidic and basic anhydrides
- Strong and weak acids and bases
- Neutralization
- pH scale
- Indicators & titration

**Assessments:**
- Reteaching the B & L theory
- Text p625 #44-70
- Lab pH
- Demo Titration & lab
- Video tape The World of Chemistry-Proton
- Bridge to Biochem Na, K & Nerves
- Chapter 19 vocabulary
- Chemistry & Society- Acid Rain
- Test Chapter 19

Lesson #15

**Enduring Understanding:** Energy and randomness are the two driving forces of change.

**Time:** 2 blocks

**Standards:** 09 NJCCCS 5.5.2.12.D.2, 5.2.12.D.4, 5.5.12.D.5, 5.2.12.C.2

**Text:** Chapter 18.4, 17.4 (Hess’s Law)

**Objectives:** SWBAT

- State two reasons why reactions occur.
- State the reasons that enthalpy changes occur in chemical reactions.
- Calculate enthalpies of reactions.

**Topics:**
- Introduction to thermodynamics

**Assessments:**
- Lab Enthalpy and Entropy p574
- Text p581 #57-64, p535 #57-61
- Demo of hand warmer.
- If time, Hess’s law lab.

**Lesson #16**

**Enduring Understanding:** Oxidation and reduction occur at the same time.

**Time:** 4 blocks

**Standards:** 09 NJCCCS 5.2.12.B.1, 5.2.12.B.2, 5.1.12.C.1, 5.1.12.A.1

**Text:** Chapter 20

**Objectives:** SWBAT

- Determine oxidation numbers.
- Identify oxidizing and reducing agents.
- Balance simple redox equations.

**Topics:**
- Redox processes
- Balancing redox equations

**Assessments:**
- Text p657 #20-40
- Lab Half-Reactions p655
- Lab Bleach it! Oxidize the Color Away p653
- Any simple equations requiring only electrons.

**Lesson #17**

**Enduring Understanding:** Form is function.

**Time:** 3 blocks

**Standards:** 09 NJCCCS 5.2.12.B.1

**Text:** Chapter 22

**Objectives:** SWBAT

- Draw hydrocarbons.
- Name hydrocarbons and their isomers.

**Topics:**
- Hydrocarbons

**Assessments:**
- Text p719 #37-53
- Lab using molecular models

**21st Century Connections**

**Cross Curricular**
Biology- chemical bonding
Physics- isotopes
Psychology-neuroscience on a molecular level
Mathematics- graphing, dimensional analysis, simple equations
History- scientists and the effects of discoveries on society
Technology- molecular modeling, power point presentations

**Character Education**
- **Honesty:**
  Students are expected to adhere to the integrity code of the high school.
  Students are expected to give honest effort on all assignments.
- **Respect:**
  Students are expected to treat all members of the classroom with courtesy and respect.
- **Service:**
  Students are expected to maintain a safe and clean environment in the classroom and the lab.
- **Responsibility:**
  Students are expected to take responsibility for their own actions.
  Students are expected to do their best and learn.

**Career**
**As per the NJCCCS**

9.1.B
- Students will communicate and comprehend written and verbal thoughts, ideas, directions, and information relative to educational and occupational settings.
- Students will select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.

9.2.A
- Students will apply communications and data analysis to the problem-solving and decision making processes in a variety of life situations.
- Students will apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.

9.2.C
- Students will model interpersonal and effective conflict resolution skills.
- Students will communicate effectively in a variety of settings with a diverse group of people.

9.2.D
- Discuss consequences and sanctions when on-the-job rules and laws are not followed.

9.2.F
- Engage in an informed discussion about rules and laws designed to promote safety and health.
- Describe and demonstrate basic first aid and safety procedures.
- Practice the safe use of tools and equipment.
- Implement safety procedures in the classroom and workplace, where appropriate.

**Technology**
**As per the NJCCCS**

8.1.12.A.2
Produce and edit a multi-page document for a commercial or professional audience using desktop publishing and/or graphics software.

8.2.12.C.2
Evaluate ethical considerations regarding the sustainability of resources that are used for the design, creation, and maintenance of a chosen product.
8.2 Technology (Engineering and Design)
Electronic balances, digital thermometers, spectronic 20’s and computers are used throughout the year.
Overview:

Chemistry is the study of materials that make up the universe and the changes these materials undergo. Chemistry Honors will prepare students to be competitive in Chemistry AP or other college level Chemistry courses.

Chemistry will be taught to help all students develop good questioning skills, to become critical & scientific thinkers, in a safe and caring environment using Chemistry concepts in alignment with the New Jersey Core Content Standards for Science.
Content: Chemistry I Honors

Philosophy:
We believe that everyone has the ability to adapt to science as a way of thinking. Every educated individual needs to have science literacy and skills. This program is designed to help students achieve an understanding of chemistry concepts. It will encourage students to look differently at the world. Students will develop the ability to use technology and sound evidence-gathering skills to support critical thinking and decision-making.


<table>
<thead>
<tr>
<th>New Jersey Core Curriculum Content Standards For Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following standards have been covered within this curriculum: 09 NJCCCS</td>
</tr>
</tbody>
</table>

5.1 Science Practices: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

A. Understand Scientific Explanations: Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

- **5.1.12.A.1** Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.
- **5.1.12.A.2** Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
- **5.1.12.A.3** Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

B. Generate Scientific Evidence Through Active Investigations: Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

- **5.1.12.B.1** Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
- **5.1.12.B.2** Mathematical tools and technology are used to gather, analyze, and communicate results.
- **5.1.12.B.3** Empirical evidence is used to construct and defend arguments.
- **5.1.12.B.4** Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

C. Reflect on Scientific Knowledge: Scientific knowledge builds on itself over time.

- **5.1.12.C.1** Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
- **5.1.12.C.2** Data and refined models are used to revise predictions and explanations.
- **5.1.12.C.3** Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.
D. Participate Productively in Science: The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

5.1.12.D.1 Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.
5.1.12.D.2 Science involves using language, both oral and written, as a tool for making thinking public.
5.1.12.D.3 Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.

5.2 Physical Science: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

A. Properties of Matter: All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

5.2.12.A.1 Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.
5.2.12.A.2 Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.
5.2.12.A.3 In the Periodic Table, elements are arranged according to the number of protons (the atomic number). This organization illustrates commonality and patterns of physical and chemical properties among the elements.
5.2.12.A.4 In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.
5.2.12.A.5 Solids, liquids, and gases may dissolve to form solutions. When combining a solute and solvent to prepare a solution, exceeding a particular concentration of solute will lead to precipitation of the solute from the solution. Dynamic equilibrium occurs in saturated solutions. Concentration of solutions can be calculated in terms of molarity, molality, and percent by mass.
5.2.12.A.6 Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.

B. Changes in Matter: Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

5.2.12.B.1 An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.
5.2.12.B.2 A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.
5.2.12.B.3 The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept.
C. Forms of Energy: Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

5.2.12.C.1 Gas particles move independently and are far apart relative to each other. The behavior of gases can be explained by the kinetic molecular theory. The kinetic molecular theory can be used to explain the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample.

There is a natural tendency for a system to move in the direction of disorder or entropy.

5.2.12.C.2 Heating increases the energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic energy of the atoms, molecules, or ions increases, the temperature of the matter increases.

Heating a pure solid increases the vibrational energy of its atoms, molecules, or ions. When the vibrational energy of the molecules of a pure substance becomes great enough, the solid melts.

D. Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

5.2.12.D.2 The driving forces of chemical reactions are energy and entropy. Chemical reactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).

5.2.12.D.3 Nuclear reactions (fission and fusion) convert very small amounts of matter into energy.

5.2.12.D.4 Energy may be transferred from one object to another during collisions.

5.2.12.D.5 Chemical equilibrium is a dynamic process that is significant in many systems, including biological, ecological, environmental, and geological systems. Chemical reactions occur at different rates. Factors such as temperature, mixing, concentration, particle size, and surface area affect the rates of chemical reactions.

Enduring Understandings

<table>
<thead>
<tr>
<th>The student will understand that:</th>
<th>Chemistry is essential to understand the physical and biological world.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Safety</td>
<td>Potential hazards are mitigated by following directions and careful technique.</td>
</tr>
<tr>
<td>Scientific Method</td>
<td>The scientific method is a database logical approach to problem solving.</td>
</tr>
<tr>
<td>Metric System</td>
<td>The metric system is a worldwide measurement system based on powers of ten.</td>
</tr>
<tr>
<td>Percent Error</td>
<td>Precision of measurement and lab technique influence the relative (percent) error.</td>
</tr>
<tr>
<td>Dimensional Analysis</td>
<td>Dimensional analysis is a unit-based logical approach to problem solving.</td>
</tr>
<tr>
<td>Significant Figures</td>
<td>Significant figures limit the degree of reportable precision and the validity of results.</td>
</tr>
<tr>
<td>Scientific Notation</td>
<td>Very large and very small numbers can be written concisely using powers of 10.</td>
</tr>
<tr>
<td>Measurement</td>
<td>Accuracy and precision and units are important to achieve correct results.</td>
</tr>
<tr>
<td>Types of Matter</td>
<td>The difference between elements, compounds and mixtures.</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Symbols Names &amp; Formulas</td>
<td>Communication has been established by the use of symbol and nomenclature systems to make the understanding of chemistry uniform among scientists.</td>
</tr>
<tr>
<td>Properties</td>
<td>Intensive are substance specific and extensive depend on the size of the sample.</td>
</tr>
<tr>
<td>Periodic Table</td>
<td>The periodic table reveals patterns and relationships between atoms and elements. These relationships can be explained by examining subatomic arrangements of particles.</td>
</tr>
<tr>
<td>Atomic Theory</td>
<td>The atomic theory is evolving to explain past as well as current experimental results.</td>
</tr>
<tr>
<td>The Mole</td>
<td>The mole is an essential concept to understanding the mechanisms of chemistry.</td>
</tr>
<tr>
<td>Conservation of Mass</td>
<td>The amount of matter in the universe is essentially constant. It is only rearranged.</td>
</tr>
<tr>
<td>Stoichiometry</td>
<td>The role of the mole in chemical calculations, and the application of dimensional analysis in their solutions.</td>
</tr>
<tr>
<td>States of Matter</td>
<td>The phases of matter are determined by the proximity of molecules and energy involved in their changes.</td>
</tr>
<tr>
<td>Thermochemistry</td>
<td>Energy is transferred in chemical and physical reactions.</td>
</tr>
<tr>
<td>Gas Laws</td>
<td>Pressure, temperature, number of particles, and volume are interrelated. Behavior of gases is governed by equations called &quot;gas laws.&quot;</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>Energy and randomness are the two driving forces of change.</td>
</tr>
<tr>
<td>Kinetics</td>
<td>The importance of molecular collision frequency in rates of chemical reactions. A successful collision requires proper orientation of particles and sufficient energy.</td>
</tr>
<tr>
<td>Equilibrium</td>
<td>Some reactions can occur both forward and backward, at the same rate of speed. An equilibrium system will respond to stress, shift and find a new balance. Experimental conditions can influence the amount of a substance produced in an equilibrium reaction.</td>
</tr>
<tr>
<td>Acid-Base</td>
<td>Acids and bases are chemical opposites and can neutralize each other. pH is a logarithmic scale that describes the concentration of H+ ions.</td>
</tr>
<tr>
<td>Redox</td>
<td>Oxidation and reduction are opposite reactions and always occur together. Applied electricity can be used to force non-spontaneous reactions to occur. Spontaneous redox reactions can be used to produce electricity.</td>
</tr>
</tbody>
</table>
### Bonding

The types of bonds a substance has influences its chemical and physical properties. Electron arrangement in a molecule can be used to predict molecular shapes.

### Organic Chemistry

Organic compounds contain one or more of the following elements: O, H, N, S, P. Isomers are differing arrangements of the same atoms. Functional groups determine chemical properties of organic substances. One set of naming rules is used for a vast number of organic molecules. Functional groups present can be used to predict products of an organic reaction.

### Essential Questions

- How should we behave in the lab?
- How are formulas written and chemicals named?
- How many atoms are in a sample?
- How are chemical reactions represented?
- How are the quantities of substances involved in chemical reactions calculated?
- What is inside the atom?
- How are the electrons arranged?
- How is the information about the elements organized?
- What are some common properties of the elements?
- What is heat?
- How are molecules held together?
- What are their shapes?
- What causes molecular motion and how is it measured?
- How are gases and the mole concept related?
- How do gases behave? How do various conditions change the characteristics of the gases?
- How do certain factors affect the rate of a reaction?
- How do changes affect reversible reactions?
- How do acids, bases and salts behave?
- How can the concentration of an acid or bases be determined?

### Student Responsibilities: Knowledge and Skills

The student will…

- Work to maintain a safe environment in the classroom and lab.
- Complete reading and other assignments in a timely fashion.
- Treat members of the classroom with courtesy and respect.
- Maintain a well-organized notebook.
- Participate as an individual and as a member of a cooperative group.
- Be here to do your best and to learn.
- Communicate effectively by acquiring and using appropriate scientific vocabulary.
- Apply appropriate math skills
### Lesson #1: Introduction

**Essential Question:** How should we behave in the lab? What is Science and Technology

**Time:** 2-3 Blocks

**Standards:** 09 NJCCCS 5.1.12.D.3, 5.1.12.A, B, C&D

**Text:** Chapter 1

**Objectives:** SWBAT
- Demonstrate safe behavior in the lab,
- Describe the difference between science and technology,
- Explain why and how we do science,
- Name the steps in scientific theory

**Topics:**
- Safe behavior and safety contract
- Pure Science
- Applied Technology
- Chemistry and 5 main branches
- Scientific method
- Use of Controls
- Need for Chemistry in everyday life
- Dangers of Bad, Pseudo or Voodoo Science

**Assessment:**
- Video tape guide- *Starting with Safety*; Lab Safety Contract
- Bean head safety cartoon; review of safety rules; safety quiz
- Quiz on Chapter 1

### Lesson #2:

**Essential Question:** How are formulas written and chemicals named?

**Time:** 5 blocks

**Standards:** 09 NJCCCS 5.2.12.B.1, 2.2.12.B.2, 5.1.12.B.3, 5.1.12.C.1

**Text:** Chapters 4.8-4.10 Ions and compounds that contain ions and 5 Nomenclature

**Objectives:**
- Demonstrate proficiency in writing chemical formulas.
- Define oxidation number and state oxidation numbers for common monatomic ions and charges for polyatomic ions
- Demonstrate proficiency in naming chemical compounds.
- Distinguish between molecular and empirical formulas.
- Demonstrate the use of coefficients to represent the number of formula units of a substance.

**Topics:**
- Names of Elements
- Chemical Formulas & Oxidation Number
- Diatomic Molecules
- Names & Formulas of Binary Inorganic Compounds
- Molecular Compounds
- Variable Oxidation State Compounds
- Organic Compounds
Lesson #3

Essential Question: How many atoms are in a sample?

Time: 9 blocks

Text: Chapter 8 Chemical Composition, Chapter 13.4

Objectives:
- Use the factor-label method in calculations.
- Use scientific notation to express and evaluate large and small measurements.
- Use the Avogadro constant to define the mole and to calculate molecular and molar mass.
- Use the molar mass to calculate the molarity of solutions, percentage composition, and empirical formulas.

Topics:
- Metric Conversions, Factor Label method
- Scientific Notation
- Molecular & Formula Molar Mass
- Molar volumes
- Molarity
- % Composition
- Empirical Formula

Assessments:
- On an as needed basis
- Text p. 229 Chapter Review
- Lab activity Peas & Rice
- Video tape “The Mole”, Demo Mole Jars,
- Lab Moles, Moles,Moles; mole quiz
- Demo Stuffed moles in a Liter, Lab Concentration of Solutions,
- Lab Bubble gum lab
- Lab % composition of a Hydrate
- Vocabulary 8; Concept Review, Lab Size of a Molecule
- Chapter 8 Test

Lesson #4

Essential Question: How are chemical reactions represented? How are the quantities of substances involved in chemical reactions calculated?

Time: 9 blocks

Text: Chapter 6 and 7 (18.1 redox)
Objectives:
- Write chemical equations to represent reactions.
- Use coefficients to balance chemical equations.
- Differentiate among five general types of chemical reactions.
- Determine the mass of a reactant or product based on the mass of another reactant or product in a reaction.
- Calculate the actual yield of a product as percentage of the theoretical yield.
- How do the 4 driving forces of a reaction help predict whether a reaction will occur
- How can you use a activity series and solubility table to predict displacement reactions

Topics:
- Write chemical equations
- Balance chemical equations
- Types of chemical reactions
- Stoichiometry
- Actual yield & theoretical yield
- 4 driving forces of a reaction
- Redox reactions driven by electron transfer
- Single replacement reactions predicted by Activity Series of metals and Halogens
- One product of Double displacement must be insoluble to drive reaction

Assessments:
- Balancing equation worksheets
- Balancing equations quiz
- Demonstration Types of Chemical Reactions
- Lab Chemical Reactions or Lab Double Displacement
- Text: p. 200 Cumulative review for chapters 6 & 7
- Chapter Tests 6 & 7

Lesson #5

Essential Question: What is inside the atom?

Time: 3 blocks


Text: Chapter 4.1-4.7 Early Atomic Theory and Structure of the Atom

Objectives:
- Determine to atomic number (Z) and mass number (A) of given isotopes of elements.
- Differentiate among the major subatomic particles.
- Calculate the average atomic mass of a mixture of isotopes of an element.
- Know the early history of atomic theory

Topics:
- Determine to atomic and mass number of given isotopes of elements
- Subatomic particles
- Average atomic mass from natural abundance of isotopes
- Democritus, Boyle, Dalton’s atomic theory,
- JJ Thosonson discovery of electron and plum pudding atomic model
- Goldstein discovery of the proton, Chadwick discovery of neutrons
- Rutherford’s gold foil experiment and discovery of the nucleus
Assessments:
- Videotape “The Atom”,
- Lab - Emission Spectroscopy
- Text p. 103 chapter review
- Test Chapter 4.1-4.7

Lesson #6

**Essential Question:** How are electrons arranged?

**Time:** 6 blocks

**Standards:** 09 NJCCCS 5.1.12.A.1, 5.2.12.B.1, 5.2.12.A.4, 5.1.12.B.1-4, 5.1.12.C.1-3,

**Text:** Chapter 11 Modern Atomic Theory

**Objectives:**
- Describe the wave mechanical view of the hydrogen atom
- Describe the electron cloud of the hydrogen atom.
- Characterize the position and velocity of an electron in an atom.
- Describe an electron cloud.
- Characterize the four quantum numbers.
- Use the Pauli exclusion principle and quantum numbers to describe an electron in an atom.
- Determine the electron configurations of the elements.
- Write electron dot diagrams for the elements.

**Topics:**
- Wave mechanical view  Position and velocity of an electron
- Quantum numbers & the Pauli exclusion principle
- Electron configurations
- Electron dot diagrams

**Assessments:**
- ChemActivity 5,
- Vocabulary 5, Concept Review 5, Critical Thinking 5,
- Flame test Lab
- Chapter Test chapter 11

Lesson #7

**Essential Question:** How is the information about the elements organized? What are some common properties of the elements?

**Time:** 4 blocks


**Text:** Chapters 11.10-11.12

**Objectives:**
- Use the periodic table to predict the electron configurations of elements.
- Explain the basis for the arrangement of the modern periodic table.
- Identify metals, nonmetals, and metalloids on the periodic table.
- Gives examples of relationship between an elements electron configuration and its placement on the periodic table.
- Predict the chemical stability of atoms using the octet rule.
- Use examples to explain the periodic properties of elements.
- State how atomic and ionic sizes change in groups and periods.
- Define ionization energy and electron affinity, and describe the factors that affect these properties.
- Use multiple ionization energies to predict oxidation numbers of elements.

**Topics:**
- Predict the electron configurations of elements
- Arrangement of the periodic table
- Metals, nonmetals, and metalloids
- Relationship between an element's electron configuration and its placement on the periodic table.
- Chemical stability
- Atomic and ionic sizes
- Ionization energy and electron affinity
- Oxidation numbers

**Assessments:**
- The Periodic Law Lab
- Chapter 6 & 10 vocabulary, Chapter 10 review Concepts,
- Chapter 6 P. 159 # 19,23,27,29,33,34
- Chapter test

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**Lesson #8**

**Essential Question:** What is heat?

**Time:** 4 blocks


**Text:** Chapter 10 Energy

**Objectives:**
- Describe conditions under which heat is transferred.
- Convert between units used to measure energy.
- Describe endothermic and exothermic processes and state the function of activation energy.
- Perform calculations involving specific heat.

**Topics:**
- Conditions under which heat is transferred
- Units used to measure energy
- Endothermic and exothermic processes
- Specific heat calculations

**Assessments:**
- Demo cold or hot pack,
- Lab Specific Heat
- Demonstration Heat vs. Temperature
- Quiz chapter 10

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**Lesson #9**
Lesson #10

Essential Question: What causes molecular motion and how is it measured?

Time: 3 blocks
Text: Chapter 13.1-13.3 Gases

Objectives:
- List and explain the basic assumptions of the kinetic theory.
- Relate pressure to molecular motion.
- Differentiate an open-arm manometer, a closed-arm manometer, and a barometer.
- Calculate the pressure of gases in both open-arm and closed-arm manometers using appropriate units.
- Relate temperature and energy transfer to molecular motion.
- Determine the relative velocities of gas molecules at the same temperature.
- Describe characteristics of substances in each of the three common states of matter in terms of the kinetic theory and bonding in the substances.

Topics:
- The kinetic theory
- Pressure & molecular motion
- Manometers
- Temperature, energy transfer and molecular motion
- Velocities of gas molecules and bonding
### Lesson #11

**Essential Question:** How are gases and the mole concept related?

**Time:** 2 blocks

**Standards:** 09 NJCCCS 5.2.12.C.1, 5.2.12.C.2, 5.2.12.A.2, 5.2.12.B.3, 5.1.12.B.2

**Text:** Chapter 13.4

**Objectives:**
- Describe relationship between, volume, temperature and pressure using KMT
- State Avogadro’s principle.
- Define molar volume.
- Explain and use the ideal gas equation.
- Compute the molecular mass of a gas form its mass, temperature, pressure, and volume.

**Topics:**
- STP
- Avogadro’s principle
- Molar volume
- The ideal gas equation
- Molecular mass of a gas
- Gas stoichiometry

**Assessments:**
- Lab Molecular Mass of Butane.
- Test

### Lesson #12

**Essential Question:** How do gases behave? How do various conditions change the characteristics of the gases?

**Time:** 5 blocks

**Standards:** 09 NJCCCS 5.2.12.C.1, 5.2.12.C.2, 5.2.12.A.2, 5.1.12.B.2, 5.1.12.C.2

**Text:** Chapter 13.5-13.10

**Objectives:**
- Describe the conditions of STP.
- Relate the laws of Boyle, Dalton, and Charles and perform calculations using these laws.
- Solve problems involving the change of more than one condition for gases.
- Describe mixture and motion of gases

**Topics:**
- Boyle’s Law
- Charles’ Law
- Gay-Lussac Law
- Combined gas Law
- Describe relationship between, volume, temperature and pressure using KMT
- Dalton’s Law of Partial Pressure
- Graham’s Law of Effusion

**Assessments:**
- Lab Charles Law
- Demo- vacuum pump; Eshed demo # 600250 - The Expansion of Gases; Soda can crush activity;
- Test Ch 13

### Lesson #13

**Essential Question:** How do certain factors affect the rate of a reaction? How do changes affect reversible reactions?

**Time:** 8 blocks


**Text:** Chapter 17 Equilibrium and Rates of Reaction

**Objectives:**
- List and describe the factors that influence the rate of reaction.
- Calculating Rates of reaction equations
- Distinguish between catalyst and inhibitor.
- Describe and determine reaction mechanisms for simple reactions.
- Determine the equilibrium constant expression for a system at equilibrium.
- Use Le Chatelier’s Principle to explain the effects of changes in concentration, pressure, and temperature on an equilibrium system.
- Relate relative amounts of product and reactant to the equilibrium constant.
- Calculate equilibrium constants and concentrations of reactants or products for a reaction.

**Topics:**
- Factors that affect the rate of reaction
- Catalyst and inhibitor
- Reaction mechanisms
- The equilibrium constant & Le Chatelier’s Principle

**Assessments:**
- Demonstration Lycopodium powder;
- Rates lab; Equilibrium Parts 1-4;
- Video tape Equilibrium
- Concept review 17; Vocabulary 17
- Test Chapter 17

### Lesson #14

**Essential Question:** How do acids, bases and salts behave? How can the concentration of an acid or bases be determined?

**Time:** 3 blocks

**Standards** 5.2.12.A.6, 5.2.12.A.5, 5.1.12.A.1

**Text:** Chapter 16
### Objectives:
- Distinguish the definitions of acids and bases and outlined in the theories of Arrhenius, Bronsted-Lowry,
- Define acidic and basic anhydrides and write formulas for them.
- Define and give examples of strong and weak acids and bases.
- Explain the concepts of neutralization and the composition of a salt and be able to name salts.
- Explain how the pH scale is used for measuring solution acidity.
- State the principles and uses of indicators.
- Explain the process of titration and perform calculations using the data from titrations.

### Topics:
- Arrhenius, Bronsted Lowry,
- Acidic and basic anhydrides
- Strong and weak acids and bases
- Neutralization reactions
- pH scale
- Indicators & titration

### Assessments:
- Lab pH
- Demo Titration & lab;
- Video tape The World of Chemistry-Proton;
- Quiz Chapter 16

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#### Lesson #15

**Enduring Understanding:** Energy and randomness are the two driving forces of change.

**Standards:** 09 NJCCCS 5.5.2.12.D.2, 5.2.12.D.4, 5.5.12.D.5, 5.2.12.C.2

**Time:** 4 blocks

**Text:** Chapter 10, Chapter 14

### Objectives:
- Explain how energy, heat and work are related.
- Classify processes as either exothermic or endothermic.
- Use a calorimeter.
- Write thermo chemical equations.
- Solve for Enthalpy using heats of reactions and changes of state of matter.
- Use Hess’s Law.

### Topics:
- The flow of energy
- Measuring and expressing enthalpy changes
- Heat in changes of state
- Calculating heats of reactions

### Assessments:
- Demo hand warmer
- Hess’s Law Lab
- Chapter 14 review pg 444
- Test chapter 14
Lesson #16

**Enduring Understanding:** Oxidation and reduction occur at the same time.

**Time:** 4 blocks

**Standards:** 09 NJCCCS 5.2.12.B.1, 5.2.12.B.2, 5.1.12.A.3, 5.1.12.B

**Text:** Chapter 18.1-18.4

**Objectives:**
- Determine oxidation numbers.
- Identify which elements are being oxidized and reduced.
- Identify oxidizing and reducing agents.
- Balance redox equations.

**Topics:**
- Redox processes
- Oxidation numbers
- Balancing redox equations

**Assessments:**
- Complete an activity series lab
- Demo a redox reaction
- Chapter 18 review p 575
- Quiz

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Lesson #17 (optional)

**Enduring Understanding:** Reactions of the nucleus convert matter to energy

**Time:** 3 blocks

**Standards:** 09 NJCCCS 5.2.12.D.3, 5.1.12.D.1, 5.1.12.D.2

**Text:** Chapter 19 Radioactivity and Nuclear Energy

**Objectives:**
- Understand Radioactivity as a natural occurrence
- Determine small amounts of matter are converted to large amounts of energy
- Investigate medical and societal uses of nuclear power

**Topics:**
- Radioactive decay and half life
- Nuclear transformations
- Products of nuclear fission and fusion
- Nuclear Energy, fission reactors, fusion research
- Effects of radiation

**Assessments:**
- M&M half life lab
- Chapter review pg 601
- Chemistry in Focus: Future Nuclear Power pg 597
- Chemistry in Focus: Nuclear Waste Disposal pg 599
- Chapter 19 test

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Lesson 18 (optional)

**Enduring Understanding:** Form is function

**Time:** 3 blocks
Text: Chapter 20 Organic Chemistry

Objectives:

- State the relationships among number of valence electrons, bonding, polarity and solubility.
- Draw hydrocarbons - saturated, unsaturated and aromatic.
- Draw isomers.
- Name hydrocarbons and their isomers.

Topics:

- Hydrocarbons
- Unsaturated hydrocarbons
- Isomers
- Hydrocarbon rings

Assessments:

- Ch. 20 #1-12
- Ch. 20 #13-17
- Ch. 20 #18-25
- Ch. 20 #26-29
- Select from #37-78
- Lab using molecular models
- Demo molecular models

21st-Century Connections

Standard 9.1 21st-Century Life & Career Skills:
All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Cross Curricular

Biology- chemical bonding, isotope dating, enzymes and catalysts, Respiration, Photosynthesis, exothermic and endothermic reactions; chemical reaction

Physics- isotopes, Kinetic energy of molecules and temperature, intermolecular and bonding forces, elect negativity, energy exchange and changes in state, fusion and fission reactions
Psychology-neuroscience on a molecular level, intermolecular forces and drug binding sites

Mathematics- graphing, dimensional analysis, simple equations, significant figures, precision and accuracy

History- Scientists and the effects of discoveries on society

Technology- molecular modeling, power point presentations, Pictures of atoms using Scanning Tunneling Microscopes, semiconductors in computers

Character Education

Honesty:
- Students are expected to adhere to the integrity code of the high school.
• Students are expected to give honest effort on all assignments.

Respect:
• Students are expected to treat all members of the classroom with courtesy and respect.

Service:
• Students are expected to maintain a safe and clean environment in the classroom and the lab.

Responsibility:
• Students are expected to take responsibility for their own actions.
• Students are expected to do their best and learn.

Throughout the year teachable moments arise to address Kindness, Responsibility, Respect, Honesty and Service.

Career Education
As per NJCCCS
9.1.B
• Students will communicate and comprehend written and verbal thoughts, ideas, directions, and information relative to educational and occupational settings.
• Students will select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.

9.2.A
• Students will apply communications and data analysis to the problem-solving and decision making processes in a variety of life situations.
• Students will apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.

9.2.C
• Students will model interpersonal and effective conflict resolution skills.
• Students will communicate effectively in a variety of settings with a diverse group of people.

9.2.D
• Discuss consequences and sanctions when on-the-job rules and laws are not followed.

9.2.F
• Engage in an informed discussion about rules and laws designed to promote safety and health.
• Describe and demonstrate basic first aid and safety procedures.
• Practice the safe use of tools and equipment.
• Implement safety procedures in the classroom and workplace, where appropriate.
• Download MSDS for chemicals used in experiments

Careers are addressed throughout the year through the videos showing current and future careers related to Chemistry. The textbooks have short synopses of careers related to the units of study.

Technology Education
As per the NJCCCS
8.1.12.A.2
Produce and edit a multi-page document for a commercial or professional audience using desktop publishing and/or graphics software.

8.2.12.C.2
Evaluate ethical considerations regarding the sustainability of resources that are used for the design,
creation, and maintenance of a chosen product.

Electronic balances, digital thermometers, spectronic 20’s and computers are used throughout the year. Computer generated lab reports using word processing, Excel and Power points.
Elements of Biology

Overview:

All SBHS students will develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment in alignment with the New Jersey Core Content Standards for Biology. Elements of Biology is intended as a second year of science and is designed to introduce students to the life sciences. It fulfills the life science requirement for high school graduation. This is a lab science, and students taking this course will be awarded an academic unit.
Content: Curriculum for Elements of Biology

Course Philosophy
Students in Elements of Biology study all the core content expected of Biology I students as per NJCCCS. Vocabulary terms and text reading will be limited to only the essentials necessary for students to develop a basic understanding of the core concepts. Laboratory experiments, demonstrations, exhibits, and class reports are included in classroom activities. Students will work both individually and in groups. Students' grades are based upon class assignments, class activities, presentations, laboratory work, laboratory reports, homework, tests, quizzes and a variety of other assessments.

Standard 5.1 Science Practices:
Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines and revises knowledge.

Strand A - Understand Scientific Explanations:
Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

Enduring Understanding:
Measurement and observation tools are used to categorize, represent and interpret the natural world.

Essential Question:
How do we build and refine models that describe and explain the natural and designed world?

Knowledge and Skills:
Students will know that:
- Mathematical, physical and computational tools are used to search for and explain core scientific concepts and principles.
- Core scientific concepts and principles represent the conceptual basis for model-building and facilitate the generation of new and productive questions.
- Interpretation and manipulation of evidence-based models are used to build and critique arguments and explanations.
- Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

Students will be able to:
- Use scientific facts, measurements, observations, and outcomes of investigations to build, refine and critique scientific explanations and arguments.
- Explain interrelationships among concepts and patterns of evidence found in different central scientific explanations and use these relationships to understand and interpret phenomena in the natural world.
- Develop and use mathematical, physical, and computational tools to build evidence-based models and to observe, measure and explain phenomena in the natural world.
- Construct and refine explanations, arguments or models of the natural world through the use of quantitative and qualitative evidence and data.
- Use scientific principles and theories to build and refine standards for data collection, posing controls, and presenting evidence.
• Evaluate and critique scientific arguments based on the experimental design, quality of the data, the method of data analysis and the evidence presented

Strand B - Generate Scientific Evidence Through Active Investigations:
Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

Enduring Understanding:
Evidence is used for building, refining, and/or critiquing scientific explanations.

Essential Questions:
What makes a question scientific?
What constitutes useful scientific evidence?

Knowledge and Skills:
Students will know that:
• Science is limited to questions of nature that are observable, testable, and repeatable.
• Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
• Mathematical tools and technology are used to gather, analyze, and communicate results.
• Empirical evidence is used to construct and defend arguments.
• Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

Students will be able to:
• Describe the realm of science as limited to questions of nature that are observable, testable and repeatable.
• Identify and form questions that generate a specific testable hypothesis.
• Design valid scientific investigations and select scientific tools and technologies to collect, analyze, and evaluate evidence as part of building and revising models and explanations.
• Build, refine, and communicate evidence-based models using mathematical, physical, and computational tools.
• Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories.
• Represent and describe mathematical relationships among variables using graphs and tables.
• Use mathematical tools to construct and evaluate claims.

Strand C - Reflect on Scientific Knowledge:
Scientific knowledge builds on itself over time.

Enduring Understanding:
Scientific knowledge builds upon itself over time.

Essential Question:
How is scientific knowledge constructed?

Knowledge and Skills:
Students will know that:
- Investigating most scientific questions requires building upon previous scientific findings and cooperation among various individuals with knowledge and expertise.
- Explanations are increasingly valuable as they account for the available evidence more completely.
- Scientific understandings, explanations and models are continually revised, refined and extended as new evidence is communicated and incorporated.

Students will be able to:
- Reflect on and revise understandings as new evidence emerges.
- Use data and new models to revise predictions and explanations.
- Understand that there might be multiple interpretations of the same phenomena.
- Consider alternative interpretations of a particular finding in relation to existing scientific evidence.
- Provide a historical example of a scientific idea which was developed, tested and then modified in light of new information and techniques.

**Strand D - Participate Productively in Science:**
The growth of scientific knowledge involves critique and communications, which are social practices that are governed by a core set of values and norms.

**Enduring Understanding:**
The growth of scientific knowledge involves critique and communication – social practices that are governed by a core set of values and norms.

**Essential Question:**
How does scientific knowledge benefit – deepen or broaden – from scientists sharing and debating ideas and information with peers?

**Knowledge and Skills:**
Students will know that:
- Science involves communication among individuals with knowledge and expertise from a variety of scientific fields.
- Science involves using language, both oral and written, as a tool for making scientific thinking public.
- Instruments and specimens must be properly cared for and that animals, when used, are to be treated humanely, responsibly and ethically.

Students will be able to:
- Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences.
- Interact with others to test new ideas, solicit and provide feedback, articulate and evaluate emerging explanations, develop shared representations and models and reach consensus explanations.
- Present and defend scientific arguments and ideas using items such as graphs, tables, journals, concept maps, and diagrams.
- Evaluate the scientific arguments and ideas of others, as well as their representations, for consistency with their claims, evidence and reasoning.
- Demonstrate how to use scientific tools and instruments and knowledge of how to handle animals with respect for their safety and welfare.
Standard 5.3 Life Science
All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

Strand A - Organization and Development:
Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

Enduring Understanding:
All living systems, from the cellular to the organism level, exhibit the interrelationship of structure and function and perform common essential life functions.

Essential Questions:
How are all living things similar?
How does structure relate to function in living systems from the cellular level to the organism level?

Knowledge and Skills:
Students will know that:
- The essential life functions are common to all living things.
- The essential life functions of cells are carried out by organelles.
- All organisms are composed of cell(s). In multicellular organisms, cells perform specialized functions. Tissues, organs, and organ systems are composed of specialized cells and function to serve the needs of cells for food, air, and waste removal, for the benefit of the whole organism.
- During the early development of an organism, cells differentiate, multiply and organize to form the many specialized cells, tissues, and organs that make up an organism. Tissues grow through cell division.
- Cells are made of complex molecules that consist mostly of a few elements. Each class of molecules has its own building blocks and specific functions.
- Cellular processes are carried out by many different types of molecules, and most are made possible by protein catalysts called enzymes.
- Cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings, including the transport of materials into and out of the cell.
- Cells divide through the process of mitosis, resulting in daughter cells that have the same genetic composition as the original cell.
- Cell differentiation is regulated through the expression of different genes during the development of complex multicellular organisms.
- There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism.

Students will be able to:
- Model and explain ways organelles work together to meet the cell’s needs.
- Define and provide examples of tissues, organs and organ systems within an organism.
• Provide an example of cell differentiation, specialization and organization to create tissues, organs and systems which work together to support the life of cells.
• Compare the benefits and limitations of existing as a single-celled organism and as a multicellular organism.
• Identify cells as plant or animal based on their structures.
• Identify the six elements most common to biological organisms: carbon, hydrogen, oxygen, nitrogen, phosphorous and sulfur
• Explain how and why each major category of organic molecules is essential to life
• Name, recognize and build examples of the building blocks of biomolecules
• Name, recognize, describe and build examples of biomolecules and describe the functions of each type in living things
• Demonstrate the properties and functions of enzymes by designing and carrying out an experiment.
• Predict the effect of a given set of environmental conditions on a cell.
• Distinguish between the processes of cellular growth (cell division) and development (differentiation)
• Describe modern applications of the regulation of cell differentiation and analyze the benefits and risks (e.g. stem cells, sex determination)

Strand B - Matter and Energy Transformations:
Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

Enduring Understanding:
All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism.

Essential Question:
How are matter and energy transformed and transferred in living systems?

Knowledge and Skills:
Students will know that:
• Plants are producers, using the energy from light to make food (sugar) from carbon dioxide and water. Plants are used as a source of food (energy) for other organisms.
• All animals, including humans, are consumers that meet their energy needs by eating other organisms or their products.
• The chemical bonds of food molecules are broken down to provide energy for the work that cells do, and is a source of the molecular building blocks from which molecules with biological activity (including proteins, dna, fats, sugars) are assembled.
• As matter cycles and energy flows through different levels of organization within living systems (cells, organs, organisms, communities), and between living systems and the physical environment, chemical elements are recombined into different products.
• The total amount of matter in a system remains constant, even though its form and locations change
• Each recombination of matter and energy results in storage and dissipation of energy into the environment as heat.
• Continual input of energy from sunlight keeps matter and energy flowing through ecosystems.
Describe the complementary relationship (cycling of matter and flow of energy) between photosynthesis and cellular respiration.
Recognize that food molecules are taken into cells and react to provide the chemical constituents needed to synthesize other molecules, and knowing that the breakdown and synthesis are made possible by enzymes

Students will be able to:
- Name and describe the sources of the reactants of photosynthesis and name and identify the importance of the products.
- Create a food web that incorporates and explains the characteristics of producers, consumers and decomposers and illustrates the flow of energy and the cycling of matter in an ecosystem
- Apply the “10% rule” of energy to explain the shape of ecological pyramids.
- Use a mathematical formula to evaluate the energy efficiency of feeding at various trophic levels.
- Predict what would happen to an ecosystem if an energy source was removed.
- Compare the process of cellular respiration to the burning of fossil fuels
- Describe role of ATP for carrying energy in organisms and draw and label the ATP cycle.

**Strand C - Interdependence:**
All animals and most plants depend on both other organisms and their environment to meet their basic needs.

**Enduring Understanding:**
The survival of organisms is affected by interactions with each other and their environment, and can be altered by human manipulation.

**Essential Questions:**
How are organisms affected by and dependent on each other?
How do organisms affect, and how are they affected by, their environment?

**Knowledge and Skills:**
Students will know that:
- Organisms both cooperate and compete in ecosystems. Symbiotic interactions among organisms of different species can be classified as: producer/consumer, predator/prey, parasite/host, scavenger/prey, decomposer/prey, mutualism, commensalism
- Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms.
- Human activities can alter the biotic and abiotic factors within an ecosystem, thereby creating changes to the overall system.

Students will be able to:
- Identify and define the following relationships: producer/consumer, predator/prey, parasite/host, scavenger/prey, decomposer/prey, mutualism, commensalism
- Explain the term niche and how a population’s niche is important to the ecosystem
- Give examples of human activities that can, intentionally or unintentionally, cause beneficial or detrimental changes in ecosystems
- Model the effect of positive and negative changes in population size on a symbiotic pairing.
- Model how natural and human-made changes in the environment will affect individual organisms and the dynamics of populations.
- Predict how natural disasters or the effects of human activities will affect population dynamics in a given ecosystem based on data and mathematical models.

**Strand D - Heredity and Reproduction:**
Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

**Enduring Understanding:**
There are predictable patterns of inheritance, and the variation that exists within a species is related to the mode of reproduction (sexual or asexual).

**Essential Questions:**
How is genetic information passed through generations?
How can modeling tools help predict inheritance?
What is the molecular basis of the inheritance and expression of traits?

**Knowledge and Skills:**
Students will know that:
- Some organisms reproduce asexually. In these organisms, all genetic information comes from a single parent. Some organisms reproduce sexually, through which half of the genetic information comes from each parent.
- The unique combination of genetic material from each parent in sexually reproducing organisms results in the potential for variation among offspring and within a population.
- Sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents.
- Genes are segments of dna molecules located in the chromosome of each cell. Dna molecules contain information that determines a sequence of amino acids, which result in specific proteins.
- Genomes can be altered by laboratory techniques for various purposes.
- Inheritance of different forms of a gene (dominant and/or recessive) affect the expression of traits in an organism

Students will be able to:
- Explain the importance of cell division in the processes of growth, repair and reproduction.
- Compare and contrast asexual and sexual reproduction and describe how sexual reproduction creates variations between individuals.
- Compare and contrast mitosis and meiosis (without emphasis on stage names)
- Demonstrate through modeling how the sorting and recombination of genes during sexual reproduction has an effect on variation in offspring (meiosis, fertilization).
- Define a gene as a discrete portion of dna contained within a chromosome.
- Build a model of the dna molecule and use it to demonstrate replication of dna.
- Explain how the structure of dna allows for replication, storage of information, synthesis of proteins, and the possibility of mutations
- Discuss ethical and societal implications of gene manipulation
- Use Punnett squares to predict possible genotypes and phenotypes
Strand E - Evolution and Diversity:
Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

Enduring Understanding:
The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce and pass those traits to offspring.

Essential Questions:
What is the evidence of evolution or changes in species over time?
How does the process of natural selection affect the diversity of species over time?
How does our understanding of the process of evolution impact our decisions in such fields as agriculture and health?

Knowledge and Skills:
Students will know that:
- New traits may result from new combinations of existing genes or from mutations of genes in reproductive cells within a population.
- Individual organisms with certain traits are more likely than others to survive and have offspring in particular environments. The advantages or disadvantages of specific characteristics can change when the environment in which they exist changes.
- Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival.
- Molecular evidence (e.g., DNA, protein structures, etc.) Substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched.
- Multiple lines of scientific evidence support the theory of evolution (including natural selection and common descent) and for the history of life on earth.
- Knowledge of evolution is used to make predictions and guide research for medical, environmental, agriculture and other fields of biology.

Students will be able to…
- Model or describe how changes in DNA (random mutations) and events that occur during sex cell formation and fertilization can result in heritable variations
- Analyze data from a natural selection simulation to describe how environmentally favored traits are perpetuated over generations
- Estimate how closely related species are, based on scientific evidence (e.g., anatomical similarities, similarities of DNA base and/or amino acid sequence).
- Describe how scientific evidence (e.g., fossil record, DNA, protein structures, etc.) Supports theories of natural selection and evolution.
- Use multiple lines of evidence (the fossil record, comparative anatomy, comparative embryology, comparative biochemistry) to construct a logical sequence in which various lines of descent branched.
- Research a specific example of the impact of evolution on a biological system (antibiotic resistance, invasive species, pesticide resistance, etc)
21st Century Connections

**Standard 8.1 Educational Technology:**
All students will use digital tools to access, manage, evaluate and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**Strand A - Technology Applications and Concepts**

**Enduring Understanding:**
The use of digital tools requires knowledge and appropriate use of operations and related applications.

**Knowledge and Skills:**
Students will be able to:
- Produce and edit a multi-page document for an audience using desktop publishing or graphics software.

**Strand E - Research and Information Literacy**

**Enduring Understanding:**
Effective use of digital tools assists in gathering and managing information.

**Knowledge and Skills:**
Students will be able to:
- Predict the impact on society of unethical use of digital tools, based on research into current news stories.

**Strand F - Critical Thinking, Problem Solving and Decision Making**

**Enduring Understanding:**
Information accessed through the use of digital tools assists in generating solutions and making decisions.

**Knowledge and Skills:**
Students will be able to:
- Select and use specialized databases to investigate an issue relevant to life science.

**Standard 8.2 Technology Education, Engineering, and Design:**
All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

**Strand B - Design: Critical Thinking, Problem Solving, and Decision-Making**

**Enduring Understanding:**
The design process is a systematic approach to solving problems.

**Knowledge and Skills:**
Students will be able to:
- Solve a science-based design challenge and build a prototype using science and math principles.
- Analyze the full costs, benefits, trade-offs, and risks related to the use of technologies in a potential career path.

9.1 21st-Century Life & Career Skills:
All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Strand A: Critical Thinking and Problem Solving

Enduring Understanding:
The ability to recognize a problem and apply critical thinking and problem-solving skills to solve the problem is a lifelong skill that develops over time.

Knowledge and Skills:
Students will be able to:
- Apply critical thinking and problem-solving strategies during structured learning experiences.

Strand B: Creativity and Innovation

Enduring Understanding:
Gathering and evaluating knowledge and information from a variety of sources, including global perspectives, fosters creativity and innovative thinking.

Knowledge and Skills:
Students will be able to:
- Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.

Strand C: Collaboration, Teamwork, and Leadership

Enduring Understanding:
Collaboration and teamwork enable individuals or groups to achieve common goals with greater efficiency. Leadership abilities develop over time through participation in groups and/or teams that are engaged in challenging or competitive activities.

Knowledge and Skills:
Students will be able to:
- Demonstrate the use of compromise, consensus, and community building strategies for carrying out different tasks, assignments, and projects.
- Demonstrate leadership and collaborative skills when participating in structured learning experiences.
- Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
9.2 Personal Financial Literacy: All students will develop skills and strategies that promote personal and financial responsibility related to financial planning, savings, investment, and charitable giving in the global economy.

Strand A: Income and Careers

Enduring Understanding:
Educational achievement, career choice, and entrepreneurial skills all play a role in achieving a desired lifestyle.

Knowledge and Skills:
Students will be able to:
- Analyze the relationship between various life science careers and personal earning goals.

9.3 Career Awareness, Exploration, and Preparation: All students will apply knowledge about and engage in the process of career awareness, exploration, and preparation in order to navigate the globally competitive work environment of the information age.

Strand C: Career Preparation

Enduring Understanding:
In order to ensure a safe and healthy work environment, a worker must follow workplace rules, policies and procedures as well as State and federal laws and regulations.

Knowledge and Skills:
Students will be able to:
- Comply with workplace child labor regulations and safety and health policies during structured learning experiences.

9.4 Career Cluster Specific:

The Agriculture, Food, & Natural Resources Career Cluster includes occupations and careers in production, processing, marketing, distribution, financing, and development of agricultural commodities and resources, including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources.

The Health Science Career Cluster includes occupations and careers in planning, managing, and providing therapeutic services, diagnostic services, health informatics, support services, and biotechnological research and development.

The Education & Training Career Cluster includes occupations and careers in planning, managing, and providing education and training services and related learning support services.

Character Education:

Honesty: Students are expected to report data honestly and in its entirety when doing laboratory work.
Kindness: Students will be expected to treat organisms (living or preserved) in a kind and ethical manner as instructed by the teacher.

Respect: Students will treat all members of the class (staff and peers) with respect and tolerance.

Responsibility: Students will work cooperatively with each other to ensure the safety of all. Students will be responsible for maintaining the integrity of laboratory supplies and equipment.

Service: Students will serve as models for others in their efforts to improve their immediate and global environments.

Cross Curricular/Interdisciplinary:

History: The historical context and important personalities involved in the growth and development of major biological theories and discoveries, for example the theory of evolution (Darwin), the discovery of the structure of DNA (Watson and Crick), the use of microscopes (Hooke), etc.

Math: Use of mathematical tools to support and analyze laboratory data. Graphical analysis of data.

English: Use of English skills (reading, writing, including grammar and editing, and speaking skills) to communicate and evaluate data and scientific ideas with peers.

Pacing Guide: This course will be run for the first time during 2011-12, and a pacing guide will be published at the end of this first year.
Overview:

Biology will be taught in a manner to help all students develop good questioning skills to become critical & scientific thinkers and questioners of facts and information, rather than mere consumers of knowledge, in a safe and caring environment using the Biology concepts following the New Jersey Core Content Standards for Biology.
Content: Biology

Philosophy:
We believe that everyone has the ability to adapt to science as a way of thinking. Every educated individual needs to have science literacy and skills. This program is designed to help students achieve an understanding of biology concepts. It will encourage students to look differently at the world. Students will develop the ability to use technology and sound evidence-gathering skills to support critical thinking and decision-making.

Textbook: The Web of Life- Biology

New Jersey Science Standards:

5.1.12: A. 1-3, B. 1-4, C. 1-3, D. 1-3
5.2.12: A. 5-6, B. 1-2, D. 5
5.3.12: A. 1-6, B. 1-6, C. 1-2, D. 1-3, E. 1-4

5.1 Science Practices:
All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

A. Understand Scientific Explanations:
Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

5.1.12.A.1 Mathematical/ physical, and computation tools are used to search for and explain core scientific concepts and principles.
5.1.12.A.2 Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
5.1.12.A.3 Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

B. Generate Scientific Evidence Through Active Investigations:
Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

5.1.12.B.1 Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
5.1.12.B.2 Mathematical tools and technology are used to gather, analyze, and communicate results.
5.1.12.B.3 Empirical evidence is used to construct and defend arguments.
5.1.12.B.4 Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

C. Reflect on Scientific Knowledge:
Scientific knowledge builds on itself over time.

5.1.12.C.1 Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
Data and refined models are used to revise predictions and explanations.

Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.

D. Participate Productively in Science:
The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.

Science involves using language, both oral and written, as a tool for making thinking public.

Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.

5.2 Physical Science:
All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

A. Properties of Matter:
All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

Solids, liquids and gases may dissolve to form solutions.

Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.

B. Changes in Matter:
Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.

A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.

D. Energy Transfer and Conservation:
The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

Chemical equilibrium is a dynamic process that is significant in many systems, including biological, ecological, environmental, and geological systems. Chemical reactions occur at different rates. Factors such as temperature, missing, concentration, particle size, and surface area affect the rates of chemical reactions.

5.3 Life Science All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order
in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics

A. Organization and Development:
Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

5.3.12.A.1 Cells are made of complex molecules that consist mostly of a few elements. Each class of molecules has its own building blocks and specific functions.
5.3.12.A.2 Cellular processes are carried out by many different types of molecules, mostly by the group of proteins known as enzymes.
5.3.12.A.3 Cellular function is maintained through the regulation of cellular processes in response to internal and external environmental conditions.
5.3.12.A.4 Cells divide through the process of mitosis, resulting in daughter cells that have the same genetic composition as the original cell.
5.3.12.A.5 Cell differentiation is regulated through the expression of different genes during the development of complex multicellular organisms.
5.3.12.A.6 There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism.

B. Matter and Energy Transformations:
Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

5.3.12.B.1 As matter cycles and energy flows through different levels of organization within living systems (cells, organs, organisms, communities), and between living systems and the physical environment, chemical elements are recombined into different products.
5.3.12.B.2 Each recombination of matter and energy results in storage and dissipation of energy into the environment as heat.
5.3.12.B.3 Continual input of energy from sunlight keeps matter and energy flowing through ecosystems.
5.3.12.B.4 Plants have the capability to take energy from light to form sugar molecules containing carbon, hydrogen, and oxygen.
5.3.12.B.5 In both plant and animal cells, sugar is a source of energy and can be used to make other carbon-containing (organic) molecules.
5.3.12.B.6 All organisms must break the high-energy chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes.

C. Interdependence:
All animals and most plants depend on both other organisms and their environment to meet their basic needs.

5.3.12.C.1 Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms.
5.3.12.C.2 Stability in an ecosystem can be disrupted by natural or human interactions.

D. Heredity and Reproduction:
Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.
5.3.12.D.1 Genes are segments of DNA molecules located in the chromosome of each cell. DNA molecules contain information that determines a sequence of amino acids, which result in specific proteins.

5.3.12.D.2 Inserting, deleting, or substituting DNA segments can alter the genetic code. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring’s success in its environment.

5.3.12.D.3 Sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents.

E. Evolution and Diversity:
Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

5.3.12.E.1 New traits may result from new combinations of existing genes or from mutations of genes in reproductive cells within a population.

5.3.12.E.2 Molecular evidence (e.g., DNA, protein structures, etc.) substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched.

5.3.12.E.3 The principles of evolution (including natural selection and common descent) provide a scientific explanation for the history of life on Earth as evidenced in the fossil record and in the similarities that exist within the diversity of existing organisms.

5.3.12.E.4 Evolution occurs as a result of a combination of the following factors:
- Ability of a species to reproduce
- Genetic variability of offspring due to mutation and recombination of genes
- Finite supply of the resources required for life
- Natural selection, due to environmental pressure, of those organisms better able to survive and leave offspring
Biology 1 addresses the following enduring understandings and essential questions.

<table>
<thead>
<tr>
<th><strong>Enduring Understandings</strong></th>
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<tbody>
<tr>
<td>- Measurements and observation tools are used to categorize, represent and interpret the natural world.</td>
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<tr>
<td>- Evidence is used for building, refining and/or critiquing scientific explanations.</td>
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<tr>
<td>- Scientific knowledge builds upon itself over time.</td>
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<tr>
<td>- The growth of scientific knowledge involves critique and communication – social practices that are governed by a core set of values and norms.</td>
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<tr>
<td>- The structures of materials determine their properties and function.</td>
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<tr>
<td>- When materials interact within a closed system, the total mass of the system remains the same.</td>
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<tr>
<td>- Changes take place due to the transfer of energy. Energy is transferred to matter through the action of forces.</td>
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<tr>
<td>- Living systems, from the cellular to the organismal level, demonstrate the complementary nature of structure and function.</td>
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<tr>
<td>- All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism.</td>
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<tr>
<td>- The survival of organisms is affected by interactions with each other and their environment, and can be altered by human manipulation.</td>
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<tr>
<td>- Organisms contain genetic information in the form of DNA that influences their traits through protein production, and they pass this on to their offspring during reproduction.</td>
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<tr>
<td>- There are predictable patterns of inheritance. Variations exist within a species, and the variation that exists is related to its mode of reproduction (asexual or sexual) and random mutations in DNA.</td>
</tr>
<tr>
<td>- The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with traits that are advantageous for a particular environment and niche survive, reproduce and pass on their traits to offspring.</td>
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<tr>
<td>- The structural and functional characteristics of an organism determine their continued survival over time under changing environmental conditions.</td>
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<table>
<thead>
<tr>
<th><strong>Essential Questions</strong></th>
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<tbody>
<tr>
<td>- What constitutes scientific evidence?</td>
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<tr>
<td>- How is scientific knowledge constructed?</td>
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<tr>
<td>- How does scientific knowledge benefit – deepen and broaden – from scientists sharing and debating ideas and information with peers?</td>
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<tr>
<td>- How do properties of materials determine their use?</td>
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<tr>
<td>- How does conservation of mass apply to the interaction of materials in a closed system?</td>
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<tr>
<td>- How can energy be transferred from one material to another?</td>
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<tr>
<td>- How does structure relate to function in living systems from the cellular to the organismal level?</td>
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<tr>
<td>- How is matter and energy transferred/transformed in living systems?</td>
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<tr>
<td>- How are organisms dependent on each other?</td>
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<tr>
<td>- How is genetic instructions contained in DNA and how are those instructions carried out by cells?</td>
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<tr>
<td>- How is genetic information passed through generations?</td>
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<tr>
<td>- How does natural selection lead to changes in populations and species over time?</td>
</tr>
<tr>
<td>- How does the understanding of genetics, reproduction, development and evolution affect the quality of human life?</td>
</tr>
</tbody>
</table>
The skills that a student is expected to gain at the end of this course are listed in two parts; one under the heading of nature and application of science and the other under biological concepts.

The following is a list of scientific habits of mind, lab skills, topics, objectives, text references, common labs, and suggested activities.

**Note: This is not a required sequence.**

### Nature and Application of Science

<table>
<thead>
<tr>
<th>Scientific Inquiry</th>
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<tbody>
<tr>
<td>• Scientific inquiry involves asking scientifically-oriented questions about the natural or designed world, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying the explanation.</td>
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<tr>
<td>• Science is distinguished from other ways of knowing by the use of empirical observations, experimental evidence, logical arguments and skepticism.</td>
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<tr>
<td>• Theories in science are well-established explanations of natural phenomena that are supported by many confirmed observations and verified hypotheses. Theories may be amended to become more complete with the introduction of new evidence.</td>
</tr>
<tr>
<td>• Investigating most real-world problems requires building upon previous scientific findings and cooperation among individuals with knowledge and expertise from a variety of scientific fields.</td>
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**Objectives for Scientific Inquiry:**

- Students will be able to…
  - Describe the realm of science as limited to questions of nature that are observable, testable, and repeatable.
  - Identify and form questions that generate a specific testable hypothesis that guide the design and breadth of the scientific investigation.
  - Conduct valid scientific investigations that control all but the testable variable in order to test a specific hypothesis.
  - Collect accurate and precise data through the selection and use of appropriate tools and technologies.
  - Organize and present data through the use of tables, diagrams, graphs.
  - Construct logical scientific explanations and present arguments that defend proposed explanations through the use of multiple lines of evidence.
  - Communicate, defend and revise the results of scientific investigations using logical arguments and connections with the known body of scientific information.
  - Use mathematics, reading, writing and technology when conducting scientific investigations and communicating results.

**History of Scientific Discovery:**

- Past scientific contributions by people of various cultures contributed to the advance of science and technology and influenced historical events and current scientific understanding of the world.
- Progress in science and technology is affected by current society. Likewise, society is greatly influenced by scientific and technological developments. As scientists challenge old claims and make new discoveries they change the way that people view the world.
- Current scientific thought is based upon prior experimentation and can be replaced or modified in light of new information and improved investigative techniques.
Objectives for Scientific Discovery:

Students will be able to:

- Examine the lives and contributions of important scientists who affected major breakthroughs in our understanding of the natural and designed world.
- Describe the origin of important scientific developments such as cell theory, genetics, and evolution.
- Give a historical example of a scientific idea which was developed, tested and then modified in light of new information and improve investigative techniques.

Relevant Lab Skills

Objectives

The students will be able to:

- Use and understand the scientific method
- Know the difference between controls, dependent and independent variables and their importance in constructing a valid experiment.
- Use multiple lines of evidence to support or reject a hypothesis.
- Recognize the importance of repeated trials and consistency in experimental methods.
- Develop observation skills and be able to distinguish between qualitative and quantitative data
- Use various types of models as a way to discover and explore scientific concepts.
- Use standard units and proper tools for weighing and measuring.
- Interpret and analyze data presented in graphs and tables.
- Prepare a formal lab report that is literate and concise, based on the format provided by the teacher.
- Provide evidence to explain, in writing, how the data support or do not support the hypothesis and to suggest sources of error and further experiments.
- Properly use and care for compound and dissecting microscopes
- Properly stain specimens and prepare a wet mount slide
- Sketch the contents of a microscope field using plate drawing technique.

This biology content of this course is designed around the five life processes all living things share, namely organization, energy, reproduction, growth and development, and response and adaptation. The curriculum provides biological literacy about these processes on several levels of biological organization, including molecule, cell, organism and population. All knowledge and skills are listed following this format.

TOPICS

Life Characteristic: Organization

MOLECULE:
The differences between atoms and molecules.
All molecules are made of atoms which bond based on their atomic structure.
All biomolecules are made of six basic atoms: hydrogen, oxygen, nitrogen, carbon, phosphorous and sulfur.
All living things are made of four basic biomolecules: proteins, lipids, carbohydrates, and nucleic acids.
The importance of water in biological systems
Characteristics of solutions: solutes and solvents

Skills and Objectives

The students will be able to:
• Describe the four basic biomolecules, give examples and functions of each in living things and identify which foods are good sources of each biomolecule.

• Build examples of biomolecules using molecular model kits.

• Explain how the function of each protein molecule depends on its specific sequence of amino acids and the shape of the molecule.

• Define the terms solutes and solvents and identify the solutes and solvents of typical solutions important to biological systems, such as blood, urine, and saline.

• Identify the properties of water that support life.

Text References:

• Chapters 2, 30

Common Lab:

• Organic Molecule Building (HONC) Lab (see Biology Activities Binder)

Suggested Activities (see Biology Activities Binder):

• Atomic structure review
• "Elements in Living Things" Coloring Page
• Biomolecules Poster/Chart
• Lab - Testing for/Identifying Organic Compounds
• Lab- Water Properties and Solutions Stations

CELL:
The cell is the fundamental unit of life that exhibits all life properties
Cell diversity: bacteria, plant, animal
Three principles of the cell theory
Basic cell structures: cell membrane, nucleus, cytoplasm, nuclear membrane, chloroplasts, and cell wall.
The differences between prokaryotes and eukaryotes
Absorption of materials by the cell- diffusion and osmosis (hypertonic, hypotonic, isotonic solutions)
Differences between passive and active transport

Objectives:
The students will be able to:

• List the three principles of the cell theory.

• Prepare a wet mount slide, draw and label the cell membrane, nucleus, nuclear membrane, cell wall, and cytoplasm in pictures of cells and describe the function of each organelle.

• Identify cells as plant, animal, or bacteria based on their structures (cell wall, cell membrane, nucleus, chloroplasts, mitochondria, ribosomes)

• Identify cells as either prokaryotes or eukaryotes based on their structures (presence or absence of nucleus and membrane-enclosed organelles).

• Define diffusion and osmosis and give examples of each.

• Explain the differences between hypertonic, hypotonic and isotonic solutions and the effect of different solutions on a cell.

• Compare and contrast the processes of passive and active transport and explain when cells would use
each process.

Text Reference:
- Chapter 3

Common Labs:
- "Viewing the Hidden World", Lab #5, Laboratory Manual of Biology. The Web of Life
- "Cells: Living Machines", Lab #6, Laboratory Manual of Biology. The Web of Life
- "Osmosis and the Incredible Egg", Lab #8 Laboratory Manual of Biology. The Web of Life or another lab that is similar

Suggested Activities (see Biology Activities Binder):
- Microscope diagram labeling or Lab Activity on parts and use of a microscope
- Cell Structure and Function Analogies Collage
- Plant/Animal/Bacteria Cell Coloring Pages and Venn Diagrams
- "Food Coloring Lab" (diffusion demo)
- Lab: "Quantitative Plasmolysis" or "Effect of Salt of Green Plant Cells"
- Lab: "Diffusion through a Membrane" (dialysis tubing)

ORGANISM:
Organisms are organized into tissues, organs, organ systems, and individuals. Classification of organisms is based on a variety of evidence. Currently, organisms are classified into three domains and six kingdoms.

Objectives:
The students will be able to:
- Define and provide examples of tissues, organs, and organ systems within an organism.
- Explain the basis for classification of organisms as based on increasingly similar characteristics.
- Explain how cell type is one characteristic used to classify organisms.
- Recognize the potential for different classification systems and changes as knowledge improves.
- Name the three domains and the six kingdoms used in classifying organisms.
- Describe shared characteristics that apply to the three domains and the six kingdoms.

Text References:
- Chapters 1,13, 25, 29

Common Lab:
- Perch Dissection

Suggested Activities (see Biology Activities Binder):
- Classification Exercises- objects, imaginary organisms, toy animals
- "Using and Making a Dichotomous Key"
- Review of lab and dissection safety
- Perch dissection support material
- Video: Perch Dissection

POPULATIONS:
Populations make up communities
Each population fills a specific niche

Communities and abiotic factors make up ecosystems

Ecosystems are interconnected by biological, chemical and physical processes.

Matter needed to sustain life in ecosystems is continually recycled through biogeochemical pathways.

Organisms within an ecosystem are interrelated and interdependent.

Human activities can alter the biotic and abiotic factors within an ecosystem, thereby creating changes to the overall system.

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<thead>
<tr>
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<tbody>
<tr>
<td>The students will be able to:</td>
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<tr>
<td>● Give an example of how populations make up communities and ecosystems.</td>
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<tr>
<td>● Define the term niche and explain how a population’s niche is important to the ecosystem.</td>
</tr>
<tr>
<td>● Describe the differences between biotic and abiotic factors and how each work together to build an ecosystem.</td>
</tr>
<tr>
<td>● Analyze a given ecosystem for its biotic and abiotic components.</td>
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<tr>
<td>● Label diagrams of the water, carbon, and nitrogen cycles.</td>
</tr>
<tr>
<td>● Identify three types of symbiotic relationships that demonstrate positive, negative and neutral results (parasitism, commensalism, and mutualism).</td>
</tr>
<tr>
<td>● Give examples of human activities that can cause beneficial or detrimental changes in ecosystems.</td>
</tr>
<tr>
<td>● Assess the impact of human activities on ecosystems and assess environmental risks and benefits associated with societal activities.</td>
</tr>
</tbody>
</table>

| Text References: |
| ● Chapters 1, 36 |

Life Characteristic: Energy
Throughout this section of the course attempts should be made to incorporate the laws of thermodynamics whenever possible.

MOLECULE:
The role of chemical reactions in biological systems
The role of catalysts to increase reaction rates
The structure and function of enzymes as protein catalysts
How substrates are changed by enzymes (lock and key model)
Factors that affect enzyme function
The importance of ATP and the ATP cycle
The role of glucose for providing energy to living things
The roles of carbohydrates and lipids in organisms

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<tr>
<td>The students will be able to:</td>
</tr>
<tr>
<td>● Explain that chemical reactions from new substances by forming or breaking chemical bonds.</td>
</tr>
<tr>
<td>● Identify several enzymes in the human body and the substrates they act upon.</td>
</tr>
<tr>
<td>● Build a model of an enzyme-substrate complex using the &quot;lock and key&quot; model.</td>
</tr>
<tr>
<td>● Describe how catalysts increase reaction rates by lowering the energy required for the reaction.</td>
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</tbody>
</table>
Identify enzymes as functional proteins used by all organisms as organic catalysts

Predict how changes in temperature, pH, and concentration may affect enzyme function

Describe the structure and role of ATP for carrying energy in organisms and draw and label the ATP cycle

State the relationship among glucose, carbohydrates, and lipids in providing energy to living things for the ATP cycle

Text References:
- Chapters 2, 4

Common Labs (see Biology Activities Binder):
- Pigment Chromatography
- "Properties of Enzymes" (Factors that Affect Enzyme Action)

Suggested Activities (see Biology Activities Binder):
- "Enzymes: Keys to Biochemical Reactions" - Reading/Questions
- "pH and Enzyme Action" - Critical Thinking Exercise, The Web of Life
- Paper or Clay Enzyme Model

CELL:

Photosynthesis
The role of the chloroplast in the plant cell
The light capturing properties of pigments, specifically chlorophyll
The chemical equation of photosynthesis and the path of reactants and products
Sugar molecules provide both energy for cellular work and building blocks for other organic molecules.

Cellular Respiration
The role of the mitochondria in cellular respiration
The differences between aerobic and anaerobic respiration
The chemical reaction of aerobic respiration and the path of reactants and products.
The process of fermentation and why the process is important to certain organisms
Calories as the unit of energy and how organisms use energy for all activities (OPTIONAL)

Objectives
The students will be able to:
- Describe the location and function of chloroplasts in plant cells.
- Write the balanced chemical equation for photosynthesis, label reactants and products; identify the source of the reactants and the importance of the products, and the role of pigments in light absorption.
- Explain that the process of photosynthesis includes both the light-dependent and light-independent reactions.
- Explain that sugars are used to provide energy for cellular work and are assembled into larger molecules with biological functions (proteins, DNA, carbohydrates, and fats).
- Describe the location and function of mitochondria in cells.
- Compare and contrast aerobic and anaerobic respiration
- Write the chemical reaction for cellular respiration, label reactants and products, and identify the source of the reactants and the importance of the products.
- Explain when cells use fermentation to obtain energy and the commercial uses for the fermentation process.
- Define the term calorie and analyze the overall calorie balance between eating food and using energy.

Text References
• Chapters 4, 30

### Suggested Activities (see Biology Activities Binder)

- Lab: Energy Flow - Photosynthesis
- Lab or demo with bromthymol blue and elodea
- Lab: Food Calorimetry

### ORGANISM:
The importance of metabolism to allow organisms to obtain and use energy
The importance of homeostasis to maintain stable internal conditions
The differences between autotrophs and heterotrophs
The roles of osmosis and diffusion in absorption and release of energy
The relationship of human digestion and respiration to absorption and use of energy (OPTIONAL)
The connections between external, internal, and cellular respiration. (OPTIONAL)

#### Objectives
The students will be able to:

- Define the term metabolism and explain why it is important for allowing organisms to use and obtain energy
- Define the term homeostasis and explain why it is important for helping organisms maintain stable internal conditions
- Compare and contrast the characteristics of autotrophs and heterotrophs
- Describe how the human body obtains energy through the processes of digestion and respiration. (OPTIONAL)
- Define the terms osmosis and diffusion and describe their importance in absorbing and releasing energy
- Describe the processes involved in gas exchange in humans (external and internal respiration) and explain how cellular respiration is dependent on those processes. (OPTIONAL)

#### Text References
- Chapters 1, 4, 30, 31

### POPULATION:
The flow of energy from the sun to organisms, then to the environment
The cycling of matter in an ecosystem
The roles of producers and consumers
The definitions and roles of herbivores, carnivores, omnivores, scavengers, and decomposers
The interpretation of ecological pyramids that depict biomass, energy flow and numbers of organisms
The definition and importance of biomagnification in ecosystems

#### Objectives
The students will be able to:

- Compare and contrast the characteristics and roles of producers and consumers.
- Create a food web that incorporates and explains the characteristics of producers, herbivores, carnivores, omnivores, scavengers, and decomposers.
Describe the relationships contained within ecological pyramids that depict biomass, energy flow, cycling of matter and numbers of organisms.

- Explain how biomagnification is related to energy flow and numbers of organisms and causes increased concentration of pollutants within higher organisms.

- Apply the "10% rule" of energy to explain the shape of ecological pyramids.

Text Reference
- Chapter 37

Suggested Activities (see Biology Activities Binder):
- Ocean Life Food Web Activity
- Create a Food Web Project
- Web of Life Activity Sheet
- Flow of Energy and Matter in the Biosphere
- What are Effects of Human Interaction in a Food Web? (DDT in Borneo)
- Pesticide Concentration in a Food Web

Life Process: Reproduction

MOLECULE:
Scientific discoveries identified DNA as the nucleic acid that stores and transmits genetic information from one generation of an organism to another.
The role of nucleotides in the formation of DNA and the pairing of complementary bases
The structure of DNA and how the structure allows for the storage of information, the expression of traits, the ability for replication and the possibility for mutations.
The structure of chromosomes as super-coiled strands of DNA.
The definition of genes as sections of DNA within the chromosomes
The selective alteration of DNA through genetic engineering for various purposes.
The ethical questions raised by genome research and manipulation

Objectives
The students will be able to:
- Describe the structure of DNA and define the component parts of the molecule
- Build a model of the DNA molecule using kits or other items and use it to demonstrate replication
- Explain how the structure of DNA allows for replication, storage of information, expression of traits and the possibility of mutations
- Describe how chromosomes are made of super-coiled DNA.
- Define a gene as a discrete portion of DNA contained within a chromosome.
- Recognize that a genome can be altered by laboratory techniques for various purposes. Identify and debate the ethical questions raised by genome research and manipulation.

Text References
- Chapter 7

Common Lab:
- Model Building – DNA and DNA Replication (suggested: Lab AIDS #71 The Molecular Model of DNA and its Replication) (see Biology Activities Binder)

Suggested Activities:
- Investigation 7B DNA Replication
Independent Project Assignment - DNA model

DNA extraction labs (see "Extraction of DNA", Lab #18, and Laboratory Manual of Biology, The Web of Life)

**CELL:**
The importance of cell division for growth, repair, and reproduction
The importance of surface area vs. volume in a cell
The stages of mitosis and cytokinesis
The process and implications of cloning
Revisit the cell theory.
The importance of Pasteur's and Redi's experiments in the debate of spontaneous generation
The major differences between mitosis and meiosis
The importance of reduction division in meiosis
The distinction between haploid and diploid cells
The role of homologous pairs of chromosomes in meiosis
The significance of cross-over during meiosis
The importance of X and Y-chromosomes for determining the sex of individuals
The process and uses of karyotyping

**Objectives**
The students will be able to:
- Explain the importance of cell division in the processes of growth, repair and reproduction.
- Calculate the surface area, volume and SA/V ratio of a model cell (cube).
- Identify the stages of mitosis and cytokinesis from visual examples and written descriptions.
- Evaluate the advantages and disadvantages of the biotechnology of human cloning.
- Describe how the experiments of Redi and Pasteur disproved the theory of spontaneous generation
- Compare and contrast the major characteristics of mitosis and meiosis - process, result
- Describe why it is necessary for the process of meiosis to reduce the chromosome number
- Explain the differences between haploid and diploid cells and give examples of each type
- Explain the importance of homologous chromosomes in meiosis
- Identify the role of the process of cross-over in increasing the variation among gametes
- Apply karyotyping to determine the sex of an individual and to determine if that individual has a chromosomal condition.

**Text Reference**
- Chapters 1, 5, 7, 9

**Common Lab**
"Diffusion and Cell Size", Lab #7 Laboratory Manual of Biology, The Web of Life

**Suggested Activities (see Biology Activities Binder):**
- Cell Cycle Chart
- Mitosis Cut and Paste/Mitosis Diagrams/Mitosis Websites
- Mitosis Plastic Cell Models
- Microscope Slides: Onion Root Tips
- Plant Mitosis Microviewers
- Animal Mitosis Microviewers
- Karyotyping Activities
- "Clues from the Karyotype", Lab #16, Laboratory Manual of Biology. The Web of Life

**ORGANISM:**
The importance of asexual reproduction for organisms due to mitosis
The role of regeneration in reproduction
The importance of sexual reproduction in producing variations between individual organisms and within populations.
How variations affect organisms and populations
Gamete formation and sexual organs in humans
The process of fertilization and its importance to restoring the original chromosome number
The role of genes and alleles in the expression of traits
The role of dominant and recessive genes in the expression of traits
The difference between an organism's genotype and phenotype
The difference between homozygous and heterozygous genotypes
The use of Punnett squares to predict possible genetic outcomes
The impact of the Human Genome Project on our understanding of the molecular basis of the inheritance and expression of traits.

**Objectives**
The students will be able to:
- Compare and contrast asexual and sexual reproduction.
- Define the term regeneration and explain how it is used as a form of reproduction.
- Describe how sexual reproduction creates variations between individuals and how these variations can affect populations.
- Explain how fertilization restores the original chromosome number.
- Explain that alleles are different forms of a gene, and that the combination of alleles determines the expression of a trait.
- Explain that one or many genes can determine an inherited trait of an individual and a single gene can influence more than one trait.
- Define and use the terms dominant and recessive to describe alleles.
- Define and use the terms genotype, phenotype, homozygous and heterozygous to accurately describe an organism's appearance and genetic makeup.
- Use Punnett squares to predict genetic outcomes.
- Describe the impact of the Human Genome Project on our understanding of the molecular basis of the inheritance and expression of traits.

**Text Reference**
- Chapters 6, 33

**Common Lab**
Asexual Reproduction Lab (potato, planaria) (see Biology Activities Binder)

**Suggested Activities (see Biology Activities Binder):**
- "Meiosis and Fertilization"
- "Genetics and Chance", Lab #13, Lab Manual of Biology. The Web of Life
### POPULATION:
The role of incomplete dominance, co-dominance, and multiple alleles in producing variations in phenotypes within populations
Pedigree analysis
Human population growth and the factors that affect population size

<table>
<thead>
<tr>
<th>Objectives</th>
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<tbody>
<tr>
<td>The students will be able to:</td>
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<tr>
<td>● Solve genetic problems incorporating incomplete dominance, co-dominance, and multiple alleles.</td>
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<tr>
<td>● Correctly analyze a pedigree to determine the genotypes of individuals and use the results to explain variations in phenotype within the pedigree.</td>
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<td>● Identify factors that affect human population growth</td>
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<tr>
<td>● Chapters 6, 36</td>
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<tr>
<th>Suggested Activities (see Biology Activities Binder):</th>
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<tr>
<td>● Nearsightedness Pedigree</td>
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<td>● Blood Typing Simulation</td>
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<tr>
<td>● &quot;Pedigree Analysis&quot;, Lab #14, Laboratory Manual of Biology. The Web of Life</td>
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### Life Process: Growth and Development

### MOLECULE:
The role of proteins in growth and development
Instructions for building proteins found in the genes of the DNA
Transcription- the structure and formation of mRNA
Translation- the formation of an amino acid chain from RNA codons
The role of amino acids in protein formation
Chromosomal mutations: deletions, duplications, inversions, and translocations
Gene mutations: point and frame shift mutations
The role of good nutrition in providing biomolecules necessary for growth and development

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<tr>
<th>Objectives</th>
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<tr>
<td>The students will be able to:</td>
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<tr>
<td>● Provide examples of proteins being used in the process of growth and development.</td>
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<tr>
<td>● Describe the process of transcription of information from DNA to RNA</td>
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<tr>
<td>● Describe the process of translation of information from mRNA to the formation of proteins</td>
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<td>● Make diagrams that show the major chromosomal mutations and explain their significance</td>
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<td>● Illustrate point and frame shift mutations and how they can affect the formation of proteins</td>
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<td>● Analyze food labels for nutritional information and evaluate the nutritional value of food</td>
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<th>Text Reference</th>
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<tr>
<td>● Chapters 8, 30</td>
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</table>
**Suggested Activities (see Biology Activities Binder):**

- Lab Zone Do It! Protein Synthesis Modeling, Pg 186 Textbook
- Strip Chromosomes/Genetic Mutations (paper model)
- Transparency 32 - Gene and Chromosome Mutations
- DNA Scavenger Hunt/DNA Code Hunt
- Food Label Reading/Analysis
- Lab - Testing Food for Organic Compounds

**CELL:**
The role of ribosomes in protein synthesis
The role of osmosis, diffusion and active transport in obtaining necessary materials for cell processes
The debate over stem cell research

**Objectives**
The students will be able to:
- Describe the ribosome as the site of protein synthesis
- Apply the concepts of osmosis, diffusion, and active transport to explain how cells obtain necessary materials for life processes
- Describe the advantages and disadvantages of stem cell research

**Text Reference**
- Chapters 3, 8, 9

**Common Lab:**
"Diffusion and Cell Size", Lab #7 Laboratory Manual of Biology, The Web of Life

**Suggested Activities (see Biology Activities Binder):**
- Socratic Seminar on stem cell research

**ORGANISM:**
The role of cell division in growth, repair, and reproduction
Growth and development can be affected by DNA mutations
Life cycles: human embryology, maturation, and puberty (OPTIONAL)
Exposure to mutagens and carcinogens increases the chance of genetic disorders and cancer
Pathogens enter the human body and multiply to create infection.
Some viral diseases destroy critical cells of the immune system, leaving the body unable to deal with multiple infection agents and cancerous cells.
Advances in technology have led to healthier lives for human beings.
Biotechnology allows for the screening and possible treatment of genetic disorders.

**Objectives**
The students will be able to:
- Explain the importance of cell division in the processes of growth, repair and reproduction for an organism
- Identify major mutagens and carcinogens found in the environment and describe how they affect DNA and may lead to genetic disorders and cancer.
- Describe the major aspects of human development starting with embryology, puberty and maturation (OPTIONAL)
- Describe the ways in which bacteria and viruses produce disease.
- Evaluate the impact of antibiotics and antiviral drugs in fighting certain diseases.
- Assess the impact of biotechnologies on diagnosis and treatment of genetic disorders.

**Text Reference**
- Chapters 8, 29, 33

**Suggested Activities (see Biology Activities Binder):**
- Genetic Counseling Role-Play or Simulation
- "Fetal Growth Rates", Lab #57 Laboratory Manual of Biology, The Web of Life
- Video: The Miracle of Life
- Lab – Antibiotic inhibition of bacterial growth
- Research of cancers and causes (i.e. skin cancer and sun, lung cancer and cigarettes)

**POPULATION:**
Mutations as a source of variation
Development of new species
Biodiversity as a sign of healthy ecosystems
Biotic and abiotic factors that affect population growth
Effects of human population growth on ecosystems

**Objectives**
The students will be able to:
- Describe how new species are formed and what factors contribute to the formation of new species
- Explain why increased biodiversity is a sign of healthy ecosystems.
- Interpret changes in population data due to biotic and abiotic factors.
- Describe how human populations affect the populations of other organisms within the environment.

**Text Reference**
- Chapters 10, 36

**Suggested Activities (see Biology Activities Binder):**
- DDT and Borneo activity
- Lab Zone Investigate It! Observing Population Growth, Pg 880 Textbook
- Yeast growth labs

**Life Process: Response and Adaptation**

**MOLECULE:**
Molecular changes that cause variations
Chemical basis of responses to stimuli in organisms

**Objectives**
The students will be able to:
- Recognize that changes in nucleotide sequences in DNA will produce variation in genotype.
- Describe the role of hormones in producing responses in stimuli in organisms

**Text Reference**
- Chapter 33

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**CELL:**
Antibiotic resistance in bacteria develops due to a change in the environment

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<th>Objectives</th>
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<tr>
<td>The students will be able to:</td>
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<tr>
<td>• Describe how the selective pressure of antibiotics in the environment leads to the evolution of populations of antibiotic-resistant bacteria</td>
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**Text Reference**
- Chapters 10, 14

<table>
<thead>
<tr>
<th>Suggested Activities (see Biology Activities Binder):</th>
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<tbody>
<tr>
<td>• Antibiotic Resistance Lab</td>
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<td>• Video: Evolution - &quot;The Evolutionary Arms Race&quot;</td>
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**ORGANISM:**
Variations exist between members of the same species. Variations can lead to adaptations.
The biological mechanisms of response in organisms, for example tropisms, "fight or flight", reflex arc, neurotransmitters, tactic response

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<tbody>
<tr>
<td>The students will be able to:</td>
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<tr>
<td>• Define the terms variations and adaptations</td>
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<td>• Explain the mechanism by which variations can become adaptations</td>
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<td>• Match examples of responses to the correct biological mechanism</td>
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**Text Reference**
- Chapters 1, 2, 10, 28, 34

<table>
<thead>
<tr>
<th>Common Lab:</th>
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<tbody>
<tr>
<td>Evolution/Natural Selection/Adaptations Lab (see Biology Activities Binder)</td>
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<table>
<thead>
<tr>
<th>Suggested Activities (see Biology Activities Binder):</th>
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<tbody>
<tr>
<td>• &quot;The Same but Different&quot;, Lab #19 Laboratory Manual of Biology, The Web of Life</td>
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<tr>
<td>• Lab Zone Do It! Can One of Your Reflex Arcs Be Stimulated? Pg 826 Text</td>
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<tr>
<td>• Bird Beak Simulation</td>
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**POPULATION:**
Adaptations allow organisms to fill available niches
The influence of Charles Darwin and the principles of natural selection
Evidence for the theory of evolution: fossil record, comparative anatomy, comparative embryology, comparative biochemistry
Biotechnology provides a tool for determining the degree of relatedness among individuals and species
New species originate through various modes: divergent and convergent evolution, co-evolution, and adaptive radiation
### Objectives
The students will be able to:

- Define the term adaptation and explain how adaptations enable organisms to fill available niches in an environment.
- Explain the role of Charles Darwin in developing the theory of evolution and list Darwin's four basic principles of natural selection.
- Describe how evidence collected through various sources has been used to support the theories of evolution and natural selection.
- Analyze a sequence of DNA or a protein to determine the degree of relatedness between individuals or species.
- Distinguish between the different modes of speciation.

### Text Reference
- Chapters 10

### Common Lab:
Some type of Evolution/Natural Selection/Adaptations Lab (see below and Biology Activities Binder)

### Suggested Activities (see Biology Activities Binder):
- "Adaptations of Birds", Lab #48, Laboratory Manual of Biology, The Web of Life
- "Vertebrate Skeletons", Lab #51, Laboratory Manual of Biology, The Web of Life
- Investigation 9.2 "Natural Selection - A Simulation" Biological Science An Ecological Approach (paper clip and tablecloths lab)
- “Why Sex?”

### Connections

#### Character Education:
- **Honesty:** Students are expected to report data honestly and in its entirety when doing laboratory work. Students are expected to adhere to the integrity code of district.
- **Kindness:** Students will be expected to treat organisms (living or preserved) in a kind and ethical manner as instructed by the teacher.
- **Respect:** Students will treat all members of the class (staff and peers) with respect and tolerance.
- **Responsibility:** Students will work cooperatively with each other to ensure the safety of all and maintenance of the laboratory equipment of the room.
- **Service:** Students will do their part to help protect the environment as taught in class.

#### Career Education:
- **9.1 21st-Century Life & Career Skills** All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.
- A. Critical Thinking and Problem Solving
- C. Collaboration, Teamwork, and Leadership
D. Cross-Cultural Understanding and Interpersonal Communication

F. Accountability (Safety), Productivity, and Ethics

- Students will be able to comprehend and communicate thoughts and ideas through verbal and written communication in an educational and occupational setting. Students will be able to select and utilize appropriate technology in situations involving teacher-approved projects relevant to occupations or higher education setting.
- Students will be able to apply communications and data analysis to the decision making and problem solving processes in a variety of life situations. Students will be able to describe and apply constructive responses and actions to criticism. Students will be able to apply the use of symbols, pictures, graphs, send other visual data to a project in an educational or occupational setting. Students will be able to recognize bias, vested interest, stereotyping, and the misuse and manipulation of information and data while formulating solutions to problems that interfere with attaining goals.
- Students will be able to apply planning and management skills in an academic or occupational setting.
- Students will be able to model interpersonal and effective conflict resolution through communication in a variety of settings with a diverse group of people.
- Students will be able to discuss consequences and sanctions when the on-the-job rules and laws are not followed. Students will be able to compare and contrast a professional code of ethics or conduct from various work fields and discuss similarities and differences.
- Students will be able to engage in an informed discussion about rules and regulations designed to promote safety and health. Students will be able to analyze the occurrence of workplace hazards. Students will be able to practice the safe use of tools and equipment. Students will be able to implement safety procedures in the classroom and workplace where appropriate.

Cross Curricular:

- History: Students will be able to discuss historical examples of how biological discoveries and theories develop and change, and how the process is influenced by societal norms and conditions, specifically: cell theory (Schlieden, Schwann, Virchow) genetics (Mendel), theory of natural selection and the process of evolution (Darwin, Lamarck), and DNA (Watson, Crick, Franklin and Wilkins)
- Math: Students will use mathematical tools to collect, graph and analyze laboratory data.
- English: Students will write a conclusion using evidence from an experiment and reasoning skills to support or reject a hypothesis.

Technology:

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.
Strand A: Technology and Operations Concepts
- 8.1.12.A.3: Students will be able to participate in online learning communities, social networks, or a virtual world as resources for life-long learning.
Strand F: Critical Thinking, Problem Solving, and Decision-Making
- 8.1.12.F.2: Students will be able to analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address educational, career, personal and social needs.

### Biology I Suggested Curriculum Pacing Guide

<table>
<thead>
<tr>
<th>Days</th>
<th>Unit &amp; Chapter</th>
<th>Outline of Topics</th>
</tr>
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</table>

158
| Page | (Unit 1) Chapter 1: Exploring Life |-Hypothesis-bases science  
-Controlled Setup: Independent, Dependent, and Control Variables  
-Science, technology and Society  
– Scientific Method  
– Differences btw “Lay” and Scientific definition of the terms: hypothesis, theory, & law. |
|---|---|---|
| 7 | Chapter 2: The Chemical Context of Life |-Elements and compounds  
-Essential elements of life  
-Subatomic particles, atomic numbers, and atomic mass  
– Biological organization progression: atoms, cells, tissues, organs .....  
-Isotopes  
-Electron configurations and electron orbitals  
-Bonds: covalent, ionic, polar covalent and Hydrogen chemical bonds  
-Water polarity and hydrogen bonding  
-Cohesion and adhesion  
-Temperature moderation  
-Universal solvent  
-pH scale |
| 6 | Chapter 2: Carbon and the Molecular Diversity of Life |Biological backbone  
-Organic vs. Inorganic Chemistry  
-Carbon bonding  
-Molecular diversity  
-Biochemistry  
–Carbohydrates and polysaccharides  
-Lipids, Fats, phospholipids, and steroids  
-Proteins, polypeptides, amino acids, and functions  
-Nucleic acid roles and structures ( DNA, RNA, ATP)  
– Biochemical form follows biological function. |
| 5 | Chapter 2: Enzymes |-Forms of energy and thermodynamics  
-Activation energy Requirements w/ & w/out Enzymes  
– E & S complex  
– Lock and Key  
– Effects of: Concentration (of E’s & S’s), pH, salinity, temperature, & SA.  
– Enzymatic Effects on Metabolism and Homeostasis  
– Substrate specificity and enzyme active sites  
-Denaturing, activation sites |
| 5 | Chapter 3: Membrane Structure and Function & Cell Organelles |– Biological organization progression: atoms, cells, tissues, organs .....  
-The Fluid Mosaic Model of the cell membrane  
-Permeability/proteins |
| 8 | Chapter 4: Photosynthesis  
Chapter 37: Cycles  
Chapter 4: Cellular Respiration: Harvesting Chemical Energy | -Osmosis, passive vs. facilitated diffusion, and concentration gradients  
-Active transport /Bulk Transport  
-Endocytosis v. Exocytosis  
– Organelles: Membrane Bound vs. Non-Membrane Bound  
-Microscopy  
-Prokaryotes v. Eukaryotes  
-Cell walls  
– Plant cells vs. Animal cells |
| 7 | Chapter 5: Cell Growth & Division  
Chapter 5: Meiosis and Sexual Life Cycles | -Chloroplast: structure and function  
-Relationship btw the colors of light  
-Photosynthetic pigments  
-Photosystems and light harvesting complexes  
-Light dependent reaction & light independent reaction  
– Xylem: water and mineral ascension  
-Stomata and role in water loss  
-Phloem: movement of sugar from source to sink  
– Water cycle / Carbon cycle  
– Chemical equation for photosynthesis  
-Steps of Aerobic respiration  
-Fermentation: ethanol v. lactic acid  
– Heterotrophic vs. Autotrophic Ecological classification  
– Chemical equation for aerobic/anaerobic respiration |
| 5 | Chapter 6: Mendel and the Gene Idea | -Key roles of cell division  
-Phases of the cell cycle, stages of mitosis, mitotic spindle, and cytokinesis  
-Binary fission, regeneration, vegetative propagation, budding and evolution of mitosis  
-Cell cycle control and cancer  
– Cell growth vs. Cell Size |
| 5 | Chapter 5: Meiosis and Sexual Life Cycles | -Inheritance of genes: Crossing Over, Linked Genes  
-Comparison of asexual and sexual reproduction  
-Sets of chromosomes and behavior during the cell cycle  
-Human Male and Female Reproductive Parts (Where mitosis & meiosis occurs here)  
-Stages of meiosis  
-Comparing mitosis and meiosis |
| Unit 2 | Chapter 6: Mendel and the Gene Idea | -Mendel’s experiments and quantitative approach  
-Laws of segregation, probability, and independent assortment  
-Mono/hybrid crosses  
-Inheritance patterns, variation, and rules of probability  
-Pedigree analysis, genetic testing and counseling  
-Recessive v. dominant disorders and multifactorial disorders |
| Chapter 6: The Chromosomal Basis of Inheritance | -Linkage, genetic recombination, and mapping  
- karyotypes  
- Chromosomal basis of sex  
- Inheritance of sex-linked genes  
- Abnormal chromosome numbers and the diseases they cause  
- Alterations of chromosome structure and human disorders  
- Deletion, insertion vs translocation |
| Chapter 7: The Molecular Basis of Inheritance  
Protein Synthesis | - DNA and the central dogma  
- The history and people behind the working model of DNA  
- Components, structure, and base pairing in DNA  
- DNA replication, Location of key steps, and critical enzymes involved |
| Chapter 8: From Gene to Protein | - Molecular components and locations of transcription and translation  
- The genetic code: triplet, codons, anti-codons converting btw the 3  
- Alteration and splicing of mRNA  
- Building a polypeptide  
- Roles and structure of tRNA and ribosomes  
- Frameshift mutations |
| Chapter 14: The Genetics of Viruses and Bacteria | - Discovery and structure of viruses  
- Viral reproductive cycles: lytic v. lysogenic  
- Bacterial genome and its replication  
- Gene transfer and recombination |
| Chapter 10: Descent with Modification: Darwinian View of Life | - Darwin’s theory  
- Theories of gradualism  
- Lamarck, and his contributions to Darwin’s ideas  
- Natural selection and adaptation in action  
- Homologous vs analogous structure the fossil record and convergent vs divergent evolution.  
- Gene pools and speciation-  
- Mutation and sexual recombination  
- gene flow  
- Biological (v. morphological) concept of species  
- Adaptive radiation / punctuated equilibrium  
- The fossil record  
- Mutation and genetic recombination as source of variation |
| Chapter 15: Protists | – DKPCOFGS |
| 5  | **Chapter 13: And Classification (Chapter 13)** | Derived characteristics of Fish vs. Amphibians *Chapter 25*
- Early amniotes, reptiles, and birds *Chapter 26*
- Derived characteristics and evolution of mammals *Chapter 26*
- Binomial nomenclature
- Liking classification and phylogeny
- The tree of life |
| 5  | **Chapter 36: Introduction to Ecology and the Biosphere** | Ecology and evolutionary biology: niches
- Organisms and the environment: Food chains and food webs
- Classification according to food consumption
- Biotic and abiotic factors
- Symbiotic relationships |
Honors Biology

Overview:

This course is more rigorous than Biology I, including a more intensive investigation of the course topics and a faster pace. In addition to the course concepts and laboratory work, emphasis will be on higher level thinking skills, writing assignments, oral reports and projects. Independent projects involving fieldwork, research, and creative presentations will be assigned. In addition, students are assigned a biology-related novel to read. Honors Biology students are expected to have independent study skills, a strong interest in science and the motivation to work hard throughout the school year. A college level textbook is used with Honors Biology I.
**Philosophy:**
Honors Biology will be taught in a manner to help all students develop good questioning skills to become critical & scientific thinkers and questioners of facts and information, rather than mere consumers of knowledge, in a safe and caring environment using the Biology concepts following and, at times, going beyond the New Jersey Core Content Standards for Biology.

**Textbook:** *Biology: Concepts and Applications, by Starr, 7ed, Brooks/Cole*

**New Jersey Science Standards:**

The following is a list of standards covered in this course content.

5.1.12: A. 1-3, B. 1-4, C. 1-3, D. 1-3
5.2.12: A. 5-6, B. 1-2, D. 5
5.3.12: A. 1-6, B. 1-6, C. 1-2, D. 1-3, E. 1-4

5.1 Science Practices:
All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

A. Understand Scientific Explanations:  
Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

5.1.12.A.1 Mathematical/physical, and computation tools are used to search for and explain core scientific concepts and principles.
5.1.12.A.2 Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
5.1.12.A.3 Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

B. Generate Scientific Evidence Through Active Investigations:  
Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

5.1.12.B.1 Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
5.1.12.B.2 Mathematical tools and technology are used to gather, analyze, and communicate results.
5.1.12.B.3 Empirical evidence is used to construct and defend arguments.
5.1.12.B.4 Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

C. Reflect on Scientific Knowledge:  
Scientific knowledge builds on itself over time.
5.1.12.C.1 Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
5.1.12.C.2 Data and refined models are used to revise predictions and explanations.
5.1.12.C.3 Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.

D. Participate Productively in Science:
The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

5.1.12.D.1 Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.
5.1.12.D.2 Science involves using language, both oral and written, as a tool for making thinking public.
5.1.12.D.3 Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.

5.2 Physical Science:
All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

A. Properties of Matter:
All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

5.2.12.A.5 Solids, liquids and gases may dissolve to form solutions.
5.1.12.A.6 Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.

B. Changes in Matter:
Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

5.2.12.B.1 An atom’s electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions.
5.2.12.B.2 A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond.

D. Energy Transfer and Conservation:
The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

5.2.12.D.5 Chemical equilibrium is a dynamic process that is significant in many systems, including biological, ecological, environmental, and geological systems. Chemical reactions occur at different rates. Factors such as temperature, missing, concentration, particle size, and surface area affect the rates of chemical reactions.
5.3 Life Science All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

A. Organization and Development:
Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

5.3.12.A.1 Cells are made of complex molecules that consist mostly of a few elements. Each class of molecules has its own building blocks and specific functions.
5.3.12.A.2 Cellular processes are carried out by many different types of molecules, mostly by the group of proteins known as enzymes.
5.3.12.A.3 Cellular function is maintained through the regulation of cellular processes in response to internal and external environmental conditions.
5.3.12.A.4 Cells divide through the process of mitosis, resulting in daughter cells that have the same genetic composition as the original cell.
5.3.12.A.5 Cell differentiation is regulated through the expression of different genes during the development of complex multicellular organisms.
5.3.12.A.6 There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism.

B. Matter and Energy Transformations:
Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

5.3.12.B.1 As matter cycles and energy flows through different levels of organization within living systems (cells, organs, organisms, communities), and between living systems and the physical environment, chemical elements are recombined into different products.
5.3.12.B.2 Each recombination of matter and energy results in storage and dissipation of energy into the environment as heat.
5.3.12.B.3 Continual input of energy from sunlight keeps matter and energy flowing through ecosystems.
5.3.12.B.4 Plants have the capability to take energy from light to form sugar molecules containing carbon, hydrogen, and oxygen.
5.3.12.B.5 In both plant and animal cells, sugar is a source of energy and can be used to make other carbon-containing (organic) molecules.
5.3.12.B.6 All organisms must break the high-energy chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes.

C. Interdependence:
All animals and most plants depend on both other organisms and their environment to meet their basic needs.

5.3.12.C.1 Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms.
5.3.12.C.2 Stability in an ecosystem can be disrupted by natural or human interactions.

D. Heredity and Reproduction:
Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

5.3.12.D.1 Genes are segments of DNA molecules located in the chromosome of each cell. DNA molecules contain information that determines a sequence of amino acids, which result in specific proteins.

5.3.12.D.2 Inserting, deleting, or substituting DNA segments can alter the genetic code. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring’s success in its environment.

5.3.12.D.3 Sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents.

E. Evolution and Diversity:
Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

5.3.12.E.1 New traits may result from new combinations of existing genes or from mutations of genes in reproductive cells within a population.

5.3.12.E.2 Molecular evidence (e.g., DNA, protein structures, etc.) substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched.

5.3.12.E.3 The principles of evolution (including natural selection and common descent) provide a scientific explanation for the history of life on Earth as evidenced in the fossil record and in the similarities that exist within the diversity of existing organisms.

5.3.12.E.4 Evolution occurs as a result of a combination of the following factors:
- Ability of a species to reproduce
- Genetic variability of offspring due to mutation and recombination of genes
- Finite supply of the resources required for life
- Natural selection, due to environmental pressure, of those organisms better able to survive and leave offspring.

STRAND 1: THE NATURE AND APPLICATION OF SCIENCE

1-1

ESSENTIAL QUESTIONS 1-1
What makes a question scientific?
What constitutes evidence?
When do you know you have enough evidence?
Why is it necessary to justify and communicate an explanation?

ENDURING UNDERSTANDING 1-1
- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying the explanation.
  - Science is limited to questions of nature that are observable, testable, and repeatable.
  - Critical thinking involves judging information, evaluating supporting statements, and thinking of alternatives before accepting the information.
• Scientists conduct investigations on physical, living or designed systems for a variety of reasons including further study of natural phenomena, replicating other’s results, testing how well a theory predicts, developing new products, and comparing theories.

• Science is distinguished from other ways of knowing by the use of empirical observations, experimental evidence, logical arguments and skepticism.

• Theories in science are explanations of natural phenomena that are supported by many confirmed observations and verified hypotheses. The application of theories allows people to make reasonable predictions. Theories may be amended to become more complete with the introduction of new evidence.

• Investigating most real-world problems requires building upon previous scientific findings and cooperation among individuals with knowledge and expertise from a variety of scientific fields.

• Investigations and public communication among scientists must meet certain criteria in order to result in new knowledge and methods (e.g., arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge; the methods and procedures used to obtain evidence must be clearly reported to enhance opportunities for further investigation.

KNOWLEDGE AND SKILLS
• SWBAT:
  o Formulate purpose of experiment in the form of a question.
  o Develop scientific questions that explain the purpose of an experiment.
  o Distinguish between observations and results and use them to formulate conclusions.
  o Describe and demonstrate the significance of observing trends while collecting multiple sets of data.

I-II
ESSENTIAL QUESTION 1- II

How have past scientific and technological contributions influenced historical events and current scientific understanding of the world?

ENDURING UNDERSTANDING 1- II
Past scientific contributions by people of various cultures contributed to the advance of science and technology and influenced historical events and current scientific understanding of the world.

• Throughout history, diverse cultures have developed scientific ideas and solved human problems through technology.

• Progress in science and invention depend heavily on what else is happening in society, and history is greatly influenced by scientific and technological developments.

• Current scientific thought is based upon prior experimentation and can be replaced or modified in light of new information and improved investigative techniques.

• As scientists challenge old claims and make new discoveries, they change the way that people view the world.

• Through the ongoing cycle of challenge and discovery, scientific knowledge grows. From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.
**KNOWLEDGE AND SKILLS 1- II**

Students will be able to:

- Examine the contributions of important scientists who affected major breakthroughs in our understanding of the natural and designed world.
- Describe the historical origin of important scientific developments such as cell theory, genetics, structure of DNA, and evolution showing how scientific theories develop, are tested and can be replaced or modified in light of new information and improved investigative techniques.
- Give examples of change and continuity as features of science; in other words, give a historical example of a scientific idea which was developed, tested and then modified in light of new information and techniques.

**1-III**

**ESSENTIAL QUESTION 1- III**

How do science and technology influence each other?

**ENDURING UNDERSTANDING 1- III**

- The development of technology and advancement in science influence each other and drive each other forward.
- Scientific inquiry is driven by the desire to understand the natural world and seeks to answer questions that may or may not directly influence humans.
- Technology is driven by human needs and seeks to solve human problems.
- Biotechnology is used in a variety of areas (e.g., agriculture, pharmaceuticals, food and beverage, fuels and energy, the environment, genetic engineering) and requires specific scientific knowledge about the natural system being modified.
- Alternatives, risks and benefits must be considered when deciding on proposals to introduce new technologies or to curtail existing ones.

**KNOWLEDGE AND SKILLS 1- III**

Students will be able to:

- Compare and contrast science and technology.
- Give an example of a technology that opened an area of biological study or improved existing biological studies.
- Define biotechnology and give examples of biotechnology.
- Explain scientific principles that led to the development of a representative biotechnology.
- Discuss the social, economic, and/or environmental consequences of a biotechnology designed to meet human wants and needs.
- Describe risks and benefits associated with the development and use of an emerging biotechnology.

**STRAND 2: MATTER, ENERGY, AND THE UNITY AND ORGANIZATION OF LIFE**

**2-I**

**ESSENTIAL QUESTIONS 2- I: UNITY, STRUCTURE AND FUNCTION**

- What are the unifying characteristics and processes of all life?
- How does structure relate to function within living systems, from molecules to organisms?
• How is matter and energy transferred/transformed in living systems?
• How do responses to internal and external cues aid in an organism’s survival?

ENDURING UNDERSTANDING 2-1: UNITY, STRUCTURE AND FUNCTION
• The living world shows unity in processes that must be performed. Within living systems, from the molecular to the organismal level, a complementary nature between structure and function exists.
• Living organisms share common characteristics that distinguish them from non-living and dead things. They obtain and use nutrients, exchange gases, sense and respond to change, grow and reproduce based on information in DNA molecules, need water and are composed of cell(s).
• All living systems demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include molecules, cells, tissues, organs, organ systems and organisms.
• The cell is the fundamental unit of life, all cells come from preexisting cells, and all organisms consist of one or more cells. The characteristics of life emerge at the cell level.
• Cells have distinct and separate structures (organelles), which perform and monitor processes essential for survival of the cell (e.g., energy use, synthesis of new molecules, and storage of genetic material). The highly specific function of each organelle is directly related to its structure. Major eukaryotic organelles include cell membrane, nucleus, nucleolus and mitochondria. In addition, plant cells have a central vacuole, cell wall and chloroplasts.
• Most organisms are single-celled while others are multi-cellular. Multi-cellular organisms consist of individual cells that cannot survive independently, while single-celled organisms are composed of one cell that can survive independently.
• Cells take highly varied forms in different plants, animals, and microorganisms. Structural variation among cells is related to the function each cell performs.

KNOWLEDGE AND SKILLS
• SWBAT:
  o Identify and justify an organism as living or non-living by using the criteria of life.
    ▪ Properties of life including growth, development, energy, reproduction, response, adaptation, and organization.
  o Describe how structure determines function
    ▪ Example of enzymes
  o Describe the conservation of energy in various ecosystems.
  o Demonstrate the transfer of matter within various ecosystems
    ▪ Including carbon, nitrogen, water, and phosphorous.
  o Identify the levels of organization among organisms from the atom to the biosphere.
  o Describe relationships between levels of organization and the complexity of the organisms.
  o Identify and describe specified organelles found within cells.

2-II
ESSENTIAL QUESTIONS 2-II: MATTER AND ENERGY
• What are the unifying characteristics and processes of all life?
• How does structure relate to function in living systems from the molecular to the organismal level?
• How are matter and energy transferred/transformed in living systems?
• How do responses to internal and external cues aid in an organism’s survival?
• How do cells communicate and maintain homeostasis?
• How and why are materials transported in and out of a cell? When does this transport occur?
• How do cells regulate their contents with regard to their environment?

ENDURING UNDERSTANDING 2-II
• Organisms respond to internal and external cues, which allow them to survive.
• The maintenance of a relatively stable internal environment is required for the continuation of life.
• Stability is challenged by changing physical, chemical, and environmental conditions. By sensing and adjusting to change, organisms keep conditions in their internal environment within a range that favors cell survival. This process in homeostasis.
• The cell membrane is dynamic and interacts with internal membranous structures as materials are transported into and out of the cell.
• The transport of materials across the membrane can be passive (does not require the expenditure of cellular energy), or active (requires the expenditure of cellular energy) depending upon membrane structure and concentration gradients.
• Concentration gradients drive the directional movements of ions and molecules into and out of cells. Transport proteins raise and lower water and solute concentrations across the cell membrane and internal membranes.
• Cells store and use information to guide their functions. DNA molecules in each cell carry coded instructions for synthesizing protein molecules. The protein molecules have important structural and regulatory functions.
• Response mechanisms operate by "telling" proteins - enzymes - when and what to build or tear down.

KNOWLEDGE AND SKILLS 2-II
Students will be able to...
• Explain how organelles of single-celled organisms function as a system to perform the same basic life processes as are performed in multi-cellular organisms (e.g., acquisition of energy, elimination of waste, reproduction, gas exchange, growth, repair, and protein synthesis).
• Explain how the cells of a multi-cellular organisms work together for the benefit of the colonial or singular organism, to perform the basic life functions.
• Provide an example of how, as a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable despite changes in the outside environment.
• Use fluid mosaic models of the plasma membrane to explain how its structure regulates the movement of materials across the membrane.
• Explain the role of concentration gradients between cells, their compartments and their environment.
• Explain the role of cell membranes as highly selective barriers (e.g., diffusion, osmosis, active transport).
• Distinguish between active and passive transport. Recognize that active transport requires energy input to move molecules from an area of low concentration to an area of high concentration (against the concentration gradient).
• Construct cell models (e.g., phenolphthalein-agar cubes, potato-iodine cubes) to investigate the relationship among cell size, surface area to volume ratio and the rates of diffusion into and out of the cell. Explain why large organisms have developed from many cells rather than one large cell.
Conduct a controlled experiment to investigate the capacity of the cell membrane to regulate how materials enter and leave the cell.

STRAND 3: REPRODUCTION, DEVELOPMENT AND HEREDITY

3-I

ESSENTIAL QUESTIONS: 3-I

- How does reproduction ensure the continuity of life?
- How does cell division provide a bridge between generations?
- How are traits passed on and why do organisms have their specific traits?
- How does the understanding and manipulation of genetics, reproduction, development and evolution affect the quality of human life?

ENDURING UNDERSTANDING 3-1: REPRODUCTION, DEVELOPMENT, AND HEREDITY

- Meiosis is the production of sex cells (gametes). The production and release of these gametes is controlled by hormones. In meiosis, the number of chromosomes is reduced by one-half and chromosomes may randomly exchange homologous parts to create new chromosomes with combinations not necessarily found in the parent cell. Independent assortment of chromosomes during meiosis also increases heritable variations within the species.
- Upon fertilization, the fusion of the gametes restores the original chromosome number, and new gene combinations lead to increased genetic variation, which, in turn, increases the likelihood of survival of the species.
- The sex chromosomes contain different genes, and therefore, certain traits will show patterns of inheritance based on gender.
- Embryological development in plants and animals involves a series of orderly changes in which cells divide and differentiate. Development is controlled by genes whose expression is influenced by internal factors (i.e., hormones) and may also be influenced by environmental factors (i.e., nutrition, alcohol, radiation, drugs, and pathogens). Alteration in this balance may interfere with normal growth and development.

KNOWLEDGE AND SKILLS 3-I

Students will be able to...

- Explain the cell cycle, how it contributes to reproduction and maintenance of the cell and/or organism, and explain where mitosis fits into the cell cycle.
- Understand the factors that cause cells to reproduce.
- Be able to describe each phase of mitosis and make a simple labeled drawing of mitosis. Indicate that resulting cells contain an identical copy of genetic information from the parent cell.
- Explain how the apportioning of cytoplasm to the daughter cells follows mitosis, a nuclear event.
- Compare and contrast asexual and sexual types of reproduction that occur on the cellular and multicellular organism levels. Understand how asexual reproduction differs from sexual reproduction. Know the advantages and disadvantages of each.
- Explain through the use of models or diagrams, why sexually-produced offspring are not identical to their parents.
- Describe the events that occur in each meiotic phase.
- Compare mitosis and meiosis; cite similarities and differences.
- Recognize that during the formation of gametes, or sex cells (meiosis), the number of chromosomes are reduced by one half, so that when fertilization occurs the diploid number is restored.
• Recognize random mutation (changes in DNA) and events that occur during gamete formation and fertilization (i.e., crossing over, independent assortment and recombination of chromosomes) as the sources of heritable variations that give individuals within a species survival and reproductive advantage or disadvantage over others in the species.

• Explain why sex-linked traits are expressed more frequently in males.

• Compare and contrast the processes of growth (cell division) and development (differentiation).

• Recognize that any environmental factor that influences gene expression or alteration in hormonal balance may have an impact on development.

• List some of the problems in cell division when control is lost.

• Recognize that cancer is a result of mutations that affect the ability of cells to regulate the cell cycle.

• Describe early embryonic development and distinguish each: oogenesis, fertilization, cleavage, gastrulation and organ formation.

• Describe the structure and function of the human male and female reproductive systems.

• Model a random process (e.g., coin toss) that illustrates which alleles can be passed from parent to offspring.

• Describe the relationship between DNA, genes, chromosomes, proteins and the genome.

• Explain that a gene is a section of DNA that directs the synthesis of a specific protein associated with a specific trait in an organism.

• Use Punnett squares, including dihybrid crosses, and pedigree charts to determine probabilities and patterns of inheritance (i.e. dominant/recessive, co-dominance, autosomal/sex-linkage, multiple-allele inheritance).

• Analyze a karyotype to determine chromosome numbers and pairs. Compare and contrast normal and abnormal karyotypes.

• Explain how sex chromosomes inherited from each parent determines the gender of the offspring.

• Explain how crossing over and Mendel’s Laws of Segregation and Independent Assortment contribute to genetic variation in sexually reproducing organisms.

• Describe how exposure to radiation, chemicals and pathogens can increase mutations.

• Explain that mutations in the DNA sequence of a gene may or may not affect the expression of the gene. Recognize that mutations may be harmful, beneficial, or have no impact on the survival of the organism.

• Explain how the type of cell (gamete or somatic) in which a mutation occurs determines heritability of the mutation.

• Predict the possible consequences of a somatic cell mutation.

• Understand the variations that can occur in observable patterns of inheritance including: co-dominance, incomplete dominance, polygenic inheritance, and pleiotropy.

• Understand the variations that can occur in observable patterns of inheritance including: co-dominance, incomplete dominance, polygenic inheritance, and pleiotropy.

• Explain the concept of gene linkage and how the probability of its occurrence is related to the distance and position on the chromosome.

• Discuss how the environment contributes to the variations in the gene expression.

• Provide possible factors contributing to an individual’s phenotypic expression.

• Understand how changes in chromosome structure and number can affect the outward appearance of organisms.

• Understand how experiments using bacteria and viruses demonstrated that instructions for producing heritable traits are encoded in DNA.

• Explain that a gene is a section of DNA that directs the synthesis of a specific protein associated with a specific trait in an organism.
• Trace how a DNA sequence, through transcription and translation, results in a sequence of amino acids.
• Demonstrate that when DNA replicates, the complementary strands separate and the old strands serve as a template for the new complementary strands. Recognize that this results in two identical strands of DNA that are exact copies of the original.
• Illustrate how a sequence of DNA nucleotides codes for a specific sequence of amino acids.

3-II
ENDURING UNDERSTANDING 3-II: TECHNOLOGICAL APPLICATIONS
The development of technology has allowed us to apply our knowledge of reproduction, development and heredity to meet human needs and wants.

• Selective breeding is used to cultivate plants and domesticated animals with desirable traits.
• Knowledge gained from research in genetics is being applied to areas of human health. Geneticists and genetic counselors may use pedigrees and Punnett squares to help predict the possibility of genetic disorders in future generations.
• The expanding ability to manipulate genetic material, reproductive processes, and embryological development creates choices that raise ethical, legal, social, and public policy questions.
• Recombinant DNA technology, which is a form of genetic engineering, involves the insertion of DNA from one cell into a cell of a different organism where the inserted DNA is expressed. Genetic engineering is being applied in biology, agriculture, and medicine in order to meet human wants and needs.
• DNA is analyzed to determine evolutionary relationships, study populations, identify individuals, and diagnose genetic disorders.

The Human Genome Project has had an enormous impact on our understanding of the molecular basis of the inheritance and expression of traits.

KNOWLEDGE AND SKILLS 3-II
Students will be able to...

• Model how the health profession uses pedigree charts to trace genetic disorders in past generations make predictions for future generations.
• Investigate how the human ability to manipulate genetic material and reproductive processes (e.g., genetic engineering, cloning, and stem-cell research) can be applied to many areas of medicine, biology, and agriculture. Evaluate the risks and benefits of various ethical, social and legal scenarios that arise from this ability.
• Explain the basic process of bacterial transformation and how it is applied in genetic engineering.
• Explain how developments in technology (e.g., gel electrophoresis, gene sequencing, bioinformatics, DNA fingerprinting) have been used to identify individuals based on DNA as well as to improve the ability to diagnose genetic diseases.
• Discuss how fruit fly experiments have helped us understand chromosomal behavior.
• List examples of phenotypic defects and describe how each can be treated.
• Explain how knowing about modern methods of genetic screening can minimize potentially tragic events
• Describe the impact of the Human Genome Project on our understanding of the molecular basis of the inheritance and expression of traits.

STRAND 4: EVOLUTION AND THE DIVERSITY OF LIFE
ESSENTIAL QUESTION 4-1
What is the evidence of evolution or changes in species over time?
How does the theory of natural selection explain the development of earth's present species?

ENDURING UNDERSTANDING 4-I: VARIATION AND EVOLUTIONARY CHANGE
The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring.

- The millions of different species of plants, animals, and microorganisms that live on Earth are the result of more than 3.5 billion years of evolution that has filled available niches with life forms. All life forms are related by descent with modification from common ancestors.

- Most of the species that have lived on Earth no longer exist. Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.

- Genetically diverse populations are more likely than genetically homogenous populations to survive changing environments.

- The theory of evolution is supported by extensive biochemical, structural, embryological, and fossil evidence.

- Natural selection is the process by which some individuals with certain heritable variations that arise from random mutation and recombination are more likely to survive and produce greater numbers of offspring than other organisms of the same species. Competition and conditions in the environment can affect which individuals survive, reproduce and pass their traits on to future generations.

- Small genetic differences can accumulate over many generations. When populations become isolated, these changes may accumulate in each subpopulation, ultimately new species may arise.

- Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms as well as the structural, embryological and molecular similarity observed among the diverse species of living organisms.

- Evolution is a change in allelic frequencies of a population over time.

- Evolution does not proceed at the same rate in all populations; nor does it progress in a linear or set direction. Environmental changes have a strong influence on the evolutionary process. Other factors that influence evolution include: sexual selection, mutation, genetic drift, and genetic modification.

- The endosymbiotic theory explains how eukaryotic cells might have evolved from prokaryotic cells.

SKILLS AND KNOWLEDGE 4-I
Students will be able to...

- Recognize that species acquire many of their unique characteristics through biological adaptations, which involve the selection of naturally occurring variations in populations.

- Observe a variety of organisms and explain how a specific trait could increase an organism’s chances of survival.

- Explain how the extinction of a species occurs when the environment changes and the adaptation of a species is insufficient to allow for its survival.

- Conduct simulations to investigate how organisms fulfill basic needs (i.e., food, shelter, air, space light/dark, and water) in a competitive environment. Relate how competition for resources can determine survival.

- Recognize random mutation (changes in DNA) and events that occur during gamete formation and fertilization (i.e., crossing over, independent assortment, and recombination) as the sources of
heritable variations that give individuals within a species survival and reproductive advantages or disadvantages.

- Conduct and analyze a natural selection simulation and use data generated from it to describe how environmentally-favored traits are perpetuated over generations resulting in species survival, while less favorable traits decrease in frequency or may lead to extinction.
- Explain how biochemical evidence, homologous structures, embryological development and fossil evidence provide evidence of evolution and confirm relationships among species and lineages.
- Explain how species evolve through descent with modification, thus allowing them to adapt to different environments.
- Describe the role of sexual selection on the evolutionary process.
- Relate a population’s survival to the reproductive success of adapted individuals in that population.
- Explain the roles of geographical isolation on the evolution of new species.
- Predict possible evolutionary implications for a population due to environmental changes over time.
- Explain why homogeneous populations may be more vulnerable to environmental changes than heterogeneous populations.
- Observe and analyze evidence of human evolution.
- Explain the scientific use of the term theory when applied to evolution.
- Sequence the events that might have led to cellular life.
- Differentiate between the three domains of life (Archae, Eubacteria, Eukarya) and explain how their cellular structure provides the basis for their classification.

**ESSENTIAL QUESTIONS 4-II**

What evidence helps scientists classify and establish relationships between species?

**ENDURING UNDERSTANDING 4-II: VARIATION AND EVOLUTIONARY CHANGE**

- The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring.
- Small genetic differences between parents and offspring accumulate over many generations, and ultimately new species may arise.
- Comparisons of the body form and structures of major groups of organisms gives clue to evolutionary relationships.
- Biologists use a system of classification to organize information of living things.
- Classification systems have changed over time as information has increased.
- The most widely used biological classification system has six kingdoms within three domains.
- All scientific names for species are made up of two Latin or Latin-like terms.
- There is a wide diversity of organisms on Earth. These organisms may be classified in a number of ways.

**KNOWLEDGE AND SKILLS 4-II**

**Students will be able to...**

- Examine an assortment of plants and animals and use simple classification keys, based on observable features, to sort and group the organisms.
- Discuss examples of how DNA and protein comparisons are used to classify organisms and determine evolutionary relationships.
- Explain how antibiotic resistance populations evolve from common bacterial populations.
• Explain how to write a scientific name using binomial nomenclature
• Discuss the difficulty of defining a species and explain the biological meaning of species
• Predict the effect of new knowledge on classification systems
• Describe methods used to reveal phylogeny.
• Compare and contrast the major characteristics of the three domains.
• Differentiate between the six kingdoms and classify organisms to the Kingdom level

4-III
ESSENTIAL QUESTION 4-III
Why is evolution considered the unifying concept of biology?

ENDURING UNDERSTANDING 4- III
Evolutionary theories help explain why life shows both unity and diversity. The concept of evolution is used to make predictions and guide research for medical, environmental, agricultural and other fields of biology.

KNOWLEDGE AND SKILLS 4-III
Students will be able to...
Research an evolution related issue (e.g. invasive species, pesticide resistance, artificial selection in plant and animal breeding, bioengineered food, vaccine development) and explain the connection between the issue and evolution.

STRAND 5: ECOLOGY AND HUMAN INTERACTION

5-1
ESSENTIAL QUESTIONS 5- I
How can change in one part of an ecosystem affect changes in other parts of the ecosystem?
How do matter and energy link organisms to each other and their environments?
How do human activities impact the environment and living systems?

ENDURING UNDERSTANDING I: INTERACTIONS WITHIN THE ENVIRONMENT
Organisms and their environments are interconnected. Changes in one part of the system will affect other parts of the system.
• Earth’s ecosystems are interconnected by biological, chemical, and physical processes. Changes in one ecosystem may have local and/or global consequences.
• The interrelationships and interdependencies of organisms may generate complex ecosystems that are stable over long periods of time and tend to have cyclic fluctuations around equilibrium.
• Ecosystems undergo major changes as a result of such factors as climate change, introduction of new species, and habitat destruction. These can be the result of natural processes and/or human impact.
• Changes in the physical, chemical, geological or biological conditions of an ecosystem can alter the diversity of species in the system. Over time, ecosystems change and populations of organisms adapt, move, or become extinct.
The carrying capacity for a specific population in an ecosystem depends on the resources available. Given adequate biotic and abiotic resources and no disease or predators, populations increase at rapid rates. Limiting factors such as resource availability, predation, pollution and climate, restrict the growth of populations in specific niches in an ecosystem.

Populations can increase through exponential growth. Higher populations result in competition for limited resources and increases in environmental pollution.

KNOWLEDGE AND SKILLS 5-I
Students will be able to...

- Understand that an ecosystem is a community of organisms that interact with one another and with their physical environment by a one-way flow of energy and a cycling of materials.
- Describe how changes in one ecosystem, (for example, due to a natural disaster or extinction of a species) can have consequences on local ecosystems as well as global ecosystems.
- Categorize populations of organisms according to the roles (producers, consumers, and decomposers) they play in an ecosystem.
- Define the following ecological terms: habitat, niche, population, community, symbiotic, competition, predation, parasitism, commensalism and mutualism.
- Be able to distinguish the physical, chemical, geologic and biological features of habitats.
- Explain how niches help to increase the diversity within an ecosystem and maximize the number of populations that can live in the same habitat.
- Using models or graphic representations, demonstrate how changes in biotic and abiotic factors affect interactions within an ecosystem.
- Describe how the biotic and abiotic factors can act as selective pressures on a population and can alter the diversity of the ecosystem over time.
- Using graphs of population data of a predator and its prey, describe the patterns observed. Explain how the interactions of predator and prey generate these patterns, and predict possible future trends in these populations.
- Construct and analyze population growth curves to show changes in a species over time.
- Be able to recognize logistic versus exponential population growth patterns in a graph.
- Define the term "carrying capacity" and identify the carrying capacity for a population in an ecosystem using graphical representations of population data.
- Describe how birth rate, death rate, emigration, and immigration contribute to a population’s growth rate
- Identify limiting factors in an ecosystem and explain why these factors prevent populations from reaching biotic potential. Predict the effects on a population if these limiting factors were removed.
- Explain why a population reaching unlimited biotic potential can be detrimental to the ecosystem.
- Describe some factors that contribute to species becoming “endangered.”

5-II
ESSENTIAL QUESTIONS 5- II
How can change in one part of an ecosystem affect changes in other parts of the ecosystem?
How do matter and energy link organisms to each other and their environments?
How do human activities impact the environment and living systems?

ENDURING UNDERSTANDING 5- II:
ENERGY FLOW & MATERIAL CYCLES IN THE ENVIRONMENT

Matter needed to sustain life is continually recycled among and between organisms and the environment. Energy from the sun flows irreversibly through ecosystems and is conserved as organisms use and transform it. Some energy is transformed to unusable heat.

- The Law of Conservation of Energy applies to ecosystems. All energy is conserved as it passes from the Sun through an ecosystem. During energy transformations, some energy is converted to unusable heat and therefore a continual input of energy from the Sun is needed to keep the process going.
- The Law of Conservation of Matter applies to ecosystems. Matter needed to sustain life in ecosystems is continually recycled (e.g., carbon cycle, water cycle, nitrogen cycle, mineral cycles) among organisms and between organisms and the environment.
- In most ecosystems, energy enters as sunlight and is transformed by producers into a biologically usable form of energy through photosynthesis. Energy then passes from organism to organism through food webs. Some energy is released from the system as heat.
- Over time, matter is transferred repeatedly from one organism to another and between organisms and their physical environment. The total amount of matter remains constant, even though its form and location change.
- All organisms, including humans, are part of and depend on food webs. Food webs recycle matter continuously as organisms are decomposed after death to return matter to the environment where it re-enters a food web.
- At each level of a food pyramid some energy is stored, but much is dissipated as heat. Consequently the number of trophic levels is finite, and the number of individuals in a population that feed at higher levels is limited.
- Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted. These chemicals become increasingly concentrated in tissues of organisms at higher trophic levels.
- Biomagnification has become a critical consideration in the regulation of chemical use in order to protect humans and other organisms from serious adverse effects.

SKILLS AND KNOWLEDGE 5- II

Students will be able to:

- Relate an ecosystem’s requirement for a continual input of energy to the inefficiency of energy transfer and the flow of energy through the ecosystem.
- Explain how ecosystems that do not rely on radiant energy obtain energy to maintain life.
- Recognize that the amount of matter in a closed ecosystem will remain constant.
- Construct food webs and trace the cycling of matter and the flow of energy (beginning with the Sun) through the food web.
- Interpret a food web diagram and identify the roles of producers, consumers, and decomposers.
- Compare, contrast, and construct pyramids of numbers, biomass and energy
- Explain how the inefficiency of energy transfer limits the number of trophic levels and affects the number of organisms and the amount of biomass at each trophic level in an ecosystem
- Illustrate how elements on Earth cycle among the biotic and abiotic components of the biosphere.
- Diagram the pathways of carbon, phosphorous and nitrogen in an ecosystem
- Diagram and label the water cycle
- Define biomagnification and explain how it has lead to unforeseen ecological consequences.
- Give an example of the accumulation of a chemical in an organism and relate the effects of the chemical on the organism to its properties and to the organism’s trophic level. (DDT in eggshells, PCBs in the fatty tissues of fish, mercury accumulation in tuna)
Explain how an understanding of biomagnification has led to more regulation of chemical use and disposal.

5-III
ESSENTIAL QUESTIONS 5-III
How can change in one part of an ecosystem affect changes in other parts of the ecosystem?
How do matter and energy link organisms to each other and their environments?
How do human activities impact the environment and living systems?

ENDURING UNDERSTANDING 5-III:
HUMAN IMPACT ON THE ENVIRONMENT & LIVING SYSTEMS
- Humans can alter the living and non-living factors within an ecosystem, thereby creating changes to the overall system.
- Humans can alter the biotic and abiotic factors within an ecosystem thereby creating changes to the overall system.
- The introduction of competing species, removal of natural habitat, alteration of native landscapes due to urban, industrial and agricultural activities, over-harvesting of species, alteration of waterways and removal of natural predators are examples of human actions that have a lasting impact on ecosystems.
- Individuals and policy-makers make decisions regarding the use of resources based on estimated benefits and risks. Impacts on environmental systems result from these decisions.
- Exponential growth of the global human population places stress on finite resources.
- Human activities and decisions concerning the use of resources can have a major effect on other species, the stability and biodiversity of ecosystems and the natural recycling processes which maintain the quality of air, water, and land.
- Advances in technology can help mitigate human impact on the environment and increase the carrying capacity of an ecosystem.

SKILLS AND KNOWLEDGE: 5-III
Students will be able to...
- Recognize that disturbances due to human action on one part of an ecosystem can have unexpected effects on other, seemingly unrelated parts of the ecosystem.
- Give examples of human activities that can cause beneficial or detrimental changes in ecosystems.
- Describe how a specific human activity (producing food, transporting materials, generating energy, disposing of waste, obtaining fresh water, or extracting natural resources) can affect ecosystems and the organisms within.
- Examine and describe how the exponential growth of the human population has affected the consumption of renewable and non-renewable resources.
- Describe and predict the impacts of the growth of human populations on resources and other species.
- Describe an example of a technology used to reduce the negative impact of human activity on the environment. (for example, phytoremediation techniques and installation of smokestack scrubbers).
- Describe how advances in technology can increase the carrying capacity of an ecosystem (for example, advances in agricultural technology have led to increases in crop yields per acre).
- Assess the impact of human activities on ecosystems and assess environmental risks and benefits associated with societal activities.
21 Century Connections

Character Education:

- **Honesty:** Students are expected to report data honestly and in its entirety when doing laboratory work. Students are expected to adhere to the integrity code of district.

- **Kindness:** Students will be expected to treat organisms (living or preserved) in a kind and ethical manner as instructed by the teacher.

- **Respect:** Students will treat all members of the class (staff and peers) with respect and tolerance.

- **Responsibility:** Students will work cooperatively with each other to ensure the safety of all and maintenance of the laboratory equipment of the room.

- **Service:** Students will do their part to help protect the environment as taught in class.

Career Education:

9.1 21st-Century Life & Career Skills All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

A. Critical Thinking and Problem Solving
C. Collaboration, Teamwork, and Leadership
D. Cross-Cultural Understanding and Interpersonal Communication
F. Accountability (Safety), Productivity, and Ethics

- Students will be able to comprehend and communicate thoughts and ideas through verbal and written communication in an educational and occupational setting. Students will be able to select and utilize appropriate technology in situations involving teacher-approved projects relevant to occupations or higher education setting.

- Students will be able to apply communications and data analysis to the decision making and problem solving processes in a variety of life situations. Students will be able to describe and apply constructive responses and actions to criticism. Students will be able to apply the use of symbols, pictures, graphs, send other visual data to a project in an educational or occupational setting. Students will be able to recognize bias, vested interest, stereotyping, and the misuse and manipulation of information and data while formulating solutions to problems that interfere with attaining goals.

- Students will be able to apply planning and management skills in an academic or occupational setting.

- Students will be able to model interpersonal and effective conflict resolution through communication in a variety of settings with a diverse group of people.

- Students will be able to discuss consequences and sanctions when the on-the-job rules and laws are not followed. Students will be able to compare and contrast a professional code of ethics or conduct from various work fields and discuss similarities and differences.

- Students will be able to engage in an informed discussion about rules and regulations designed to promote safety and health. Students will be able to analyze the occurrence of workplace hazards. Students will be able to practice the safe use of tools and equipment. Students will be able to implement safety procedures in the classroom and workplace where appropriate.

Cross Curricular:
- History: Students will be able to discuss historical examples of how biological discoveries and theories develop and change, and how the process is influenced by societal norms and conditions, specifically: cell theory (Schlieden, Schwann, Virchow) genetics (Mendel), theory of natural selection and the process of evolution (Darwin, Lamarck), and DNA (Watson, Crick, Franklin and Wilkins).
- Math: Students will use mathematical tools to collect, graph and analyze laboratory data.
- English: Students will write a conclusion using evidence from an experiment and reasoning skills to support or reject a hypothesis.

**Technology:**

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

Strand A: Technology and Operations Concepts
- 8.1.12.A.3: Students will be able to participate in online learning communities, social networks, or a virtual world as resources for life-long learning.

Strand F: Critical Thinking, Problem Solving, and Decision-Making
- 8.1.12.F.2: Students will be able to analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address educational, career, personal and social needs.

### Honor Biology I Curriculum Pacing Guide

<table>
<thead>
<tr>
<th># of Weeks</th>
<th>Unit &amp; Chapter #’s</th>
<th>Outline of Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>(Unit 1)</td>
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<tr>
<td></td>
<td>Chapter 1: Exploring Life</td>
<td>-Hypothesis-bases science</td>
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<tr>
<td></td>
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<td>-Controlled Setup: Independent, Dependent, and Control Variables</td>
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<tr>
<td></td>
<td></td>
<td>-Science, technology and Society</td>
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<tr>
<td></td>
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<td>– Scientific Method</td>
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<td></td>
<td></td>
<td>– Differences btw “Lay” and Scientific definition of the terms: hypothesis, theory, &amp; law.</td>
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<tr>
<td>7</td>
<td>Chapter 2: The Chemical Context of Life</td>
<td>-Elements and compounds</td>
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<tr>
<td></td>
<td></td>
<td>-Essential elements of life</td>
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<tr>
<td></td>
<td></td>
<td>-Subatomic particles, atomic numbers, and atomic mass</td>
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<tr>
<td></td>
<td></td>
<td>– Biological organization progression: atoms, cells, tissues, organs</td>
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<tr>
<td></td>
<td></td>
<td>– Isotopes</td>
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<tr>
<td></td>
<td></td>
<td>-Electron configurations and electron orbitals</td>
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<tr>
<td></td>
<td></td>
<td>-Bonds: covalent, ionic, polar covalent and Hydrogen chemical bonds</td>
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<tr>
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<td>-Water polarity and hydrogen bonding</td>
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<tr>
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<td>-Cohesion and adhesion</td>
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<td>-Temperature moderation</td>
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<td>-Insulation and ice properties</td>
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<td>-Universal solvent</td>
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<td></td>
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<td>-pH scale</td>
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<tr>
<td>6</td>
<td>Chapter 3: Carbon and the Molecular</td>
<td>Biological backbone</td>
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<tr>
<td></td>
<td></td>
<td>-Organic vs. Inorganic Chemistry</td>
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<tr>
<td></td>
<td></td>
<td>-Carbon bonding</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
</tbody>
</table>
| **Diversity of Life** | | -Molecular diversity  
-Monomers v. polymers  
-Biochemistry  
- Carbohydrates and polysaccharides  
- Lipids, Fats, phospholipids, and steroids  
- Proteins, polypeptides, amino acids, and functions  
- Nucleic acid roles and structures (DNA, RNA, ATP)  
- Dehydration and condensation reactions  
- ID of key chemical functional groups: carboxyl, hydroxyl …  
- Correct ID of different biochemical families via viewing a mixture of biochemical structures.  
- Biochemical form follows biological function. |
| **5** | **Chapter 4: Enzymes** | -Forms of energy and thermodynamics  
- Exergonic v. endergonic reactions  
- Laws of energy transformation  
- Activation energy Requirements w/ & w/out Enzymes  
- E & S complex  
- Lock and Key  
- Effects of: Concentration (of E’s & S’s), pH, salinity, temperature, inhibitors, & SA.  
- Enzymatic Effects on Metabolism and Homeostasis  
- Substrate specificity, catalysis, and enzyme active sites  
- Denaturing, activation sites, and allosteric sites  
- Organization of chemistry of life into metabolic pathways |
| **8** | **Chapter 6: Membrane Structure and Function & Cell Organelles** | -Membrane proteins, carbohydrates, and cholesterol, and phospholipid composition.  
- The Fluid Mosaic Model of the cell membrane  
- Permeability and transport proteins  
- Osmosis, passive vs. facilitated diffusion, and concentration gradients  
- Active transport  
- Endocytosis v. Exocytosis  
- Organelles: Membrane Bound vs. Non-Membrane Bound  
- Microscopy  
- Prokaryotes v. Eukaryotes  
- Nucleus, nucleolus, and ribosomes  
- Endoplasmic reticulum and golgi apparatus  
- Lysosomes and vacuoles  
- Mitochondria. chloroplasts,  
- Cytoskeleton  
- Cell walls  
- Plant cells vs. Animal cells  
- Endosymbiotic Theory |
| **7** | **Chapter 10: Photosynthesis**  
**Chapter 10: Cycles**  
**Chapter 9:** | -Chloroplast: structure and function  
-Nature of sunlight  
-Photosynthetic pigments  
-Photosystems and light harvesting complexes  
- Light dependent reaction & light independent reaction |
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</tr>
</thead>
</table>
|            | **Cellular Respiration: Harvesting Chemical Energy** | - Scaffolded learning of cell membrane structure/function, and diffusion during the chemiosmosis explanation  
  - Xylem: water and mineral ascension  
  - Effects of transpiration on wilting and leaf temperature  
  - Stomata and role in water loss  
  - Phloem: movement of sugar from source to sink  
  - Water cycle  
  - Anabolic v. catabolic pathways  
  - Glycolysis, Kreb’s cycle, and electron transport chain (Counting C’s, & ATP)  
  - Fermentation: ethanol v. lactic acid  
  - Evolutionary significance of glycolysis  
  - Heterotrophic vs. Autotrophic Ecological classification  
  - Comparison of chemiosmosis in chloroplasts and mitochondria |
| 5          | Chapter 12: Cell Growth & Division | - Key roles of cell division  
  - Phases of the cell cycle, stages of mitosis, mitotic spindle, and cytokinesis  
  - Binary fission, regeneration, vegetative propagation, budding and evolution of mitosis  
  - Cell cycle control and cancer  
  - Cell growth vs. Cell Size |
| 5          | Chapter 13: Meiosis Sexual Life Cycles | - Inheritance of genes: Crossing Over, Linked Genes  
  - Comparison of asexual and sexual reproduction  
  - Sets of chromosomes and behavior during the cell cycle  
  - Human Male and Female Reproductive Parts (Where mitosis & meiosis occurs here)  
  - Stages of meiosis  
  - Comparing mitosis and meiosis  
  - Origins and evolutionary significance of genetic variation  
  - Embryonic development: cell division, differentiation |
| 7          | Chapter 14: Mendel and the Gene Idea | - Mendel’s experiments and quantitative approach  
  - Laws of segregation, probability, and independent assortment  
  - Monohybrid v. dihybrid crosses  
  - Nature v. nurture  
  - Inheritance patterns, variation, and rules of probability  
  - Pedigree analysis, genetic testing and counseling  
  - Recessive v. dominant disorders and multifactorial disorders |
| 6          | Chapter 15: The Chromosomal Basis of Inheritance | - Linkage, genetic recombination, and mapping  
  - Chromosomal basis of sex  
  - Inheritance of sex-linked genes and X inactivation in females  
  - Abnormal chromosome numbers  
  - Alterations of chromosome structure and human disorders  
  - Genomic imprinting and inheritance of organelle genes |
| 5          | Chapter 16: The Molecular Basis of Inheritance Protein Synthesis | - DNA and the central dogma  
  - The history and people behind the working model of DNA  
  - Components, structure, and base pairing in DNA  
  - DNA replication (leading/lagging), Okazaki fragments, |
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</table>
| 5          | Chapter 17: From Gene to Protein | -Molecular components of transcription and translation  
- The genetic code  
- Alteration and splicing of mRNA  
- Building a polypeptide  
- Roles and structure of tRNA and ribosomes |
| 3          | Chapter 18: The Genetics of Viruses and Bacteria | - Discovery and structure of viruses  
- Viral reproductive cycles: lytic v. lysogenic  
- Evolution of viruses  
- Viruses, viroids, and prions: pathogens in plants and animals  
- Bacterial genome and its replication  
- Mutation and genetic recombination as source of variation  
- Gene transfer and recombination  
- Symbiotic relationships |
| 8          | Chapter 22: Descent with Modification: Darwinian View of Life | - Darwin’s theory  
- Theories of gradualism  
- Lamarck, and his contributions to Darwin’s ideas  
- Natural selection and adaptation in action  
- Homology, biogeography, and the fossil record  
- Gene pools and allele frequencies  
- Population genetics and the “S” curve  
- Mutation and sexual recombination  
- Genetic drift and gene flow  
- Biological (v. morphological) concept of species  
- Adaptive radiation  
- The fossil record  
- Morphological and molecular homologies |
| 5          | Chapter 28: Protists And Classification | - DKPCOFGS  
Derived characteristics of Fish vs. Amphibians  
- Early amniotes, reptiles, and birds  
- Derived characteristics and evolution of mammals  
- Binomial nomenclature  
- Liking classification and phylogeny  
- The tree of life |
| 5          | Chapter 50: Introduction to Ecology and the Biosphere | - Ecology and evolutionary biology  
- Organisms and the environment  
- Dispersal and distribution  
- Behavior and habitat selection  
- Biotic and abiotic factors |
Astronomy

Overview:

Astronomy is an lab/activity-based course focused on the universe beyond the earth. The course begins with study and observation of the moon then moves on to the solar system, stellar evolution, galaxies, and ends with the study of theories on how the universe has evolved. The course will include observation and interpretation of objects such as planets, moons, comets, meteors, and other cosmic phenomena.

Students will be expected to work independently, cooperatively, and at times, competitively. Students will do project work throughout the semester. The projects are designed to demonstrate or illustrate concepts, and are inquiry-based. Grades are based upon class assignments, class activities, projects, presentations, homework, tests, quizzes and a variety of other assessments.
Content: Astronomy

Philosophy:
The course begins with the study of the Moon, and moves away from the Earth through study of the planets and other objects in our Solar System, stars and constellations, types of galaxies, and black holes and wormholes along with a variety of other topics. The course is highly project based and focused on cooperative group work. Students will be asked to do some at-home observation of the night sky.

Astronomy will be taught in a manner to help all students develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment using the Astronomy concepts following the New Jersey Core Content Standards for Astronomy.

Desired Results

NJ Content Standards
The following standards have been covered within this curriculum:

NJCCS 5.4 Earth Systems Science
All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe.

Strand A. Objects in the Universe
Our universe has been expanding and evolving for 13.7 billion years under the influence of gravitational and nuclear forces. As gravity governs its expansion, organizational patterns, and the movement of celestial bodies, nuclear forces within stars govern its evolution through the processes of stellar birth and death. These same processes governed the formation of our solar system 4.6 billion years ago.

Enduring Understanding(s)
- Early 17th century work caused astronomers to abandon a geocentric model of the Solar System and to adopt a heliocentric model of the Solar System.
- Based on a variety of data sources, astronomers’ best estimate is that the Solar System is about 4.6 billion years old.
- Stars evolve through a predictable life cycle.
- Astronomers’ best estimates state that the Sun is one of 200 billion stars in the Milky Way, and that the Milky Way is one of over 100 billion galaxies that make up the Universe.
- The most widely accepted theory on the origin of the Universe is called the Big Bang theory, and it estimates that the Universe is 13.7 billions year old.
- The Big Bang theory states that the universe has been expanding since its beginning (about 13.7 billion years ago).

Essential Questions(s)
- How do we know the Sun is the center of the Solar System?
- How old is the Solar System?
- How is a star formed?
- How do astronomers estimate the number of stars in the galaxy? The universe?
- How did the Universe begin?
- How old is the Universe?
Knowledge & Skills:

Students will know…

MOON
- How the Moon was formed.
- How big the Moon is compared to the Earth and other moons in the Solar System.
- How the Earth/Moon system is unique.
- How the Moon affects the Earth via phases, tides, eclipses, etc.

SOLAR SYSTEM
- How planets initially formed.
- The relative size and distance between the planets in the Solar System.
- Why the planets are so different in size and composition depending on their location in the Solar System.
- The IAU’s accepted definition of a planet (i.e. why Pluto is not a true planet).
- The role of other objects in the Solar System (i.e. asteroids, comets).
- Kepler’s laws of planetary motion.

STARS
- How stars are formed.
- Stars follow a specific life cycle that has been depicted in a diagram created by astronomers Hertzsprung and Russell in the early 1900s.
- The process of controlled thermonuclear fusion that occurs during a star’s main-sequence life cycle stage.
- The differences in high and low mass stars.
- How star sampling and estimation occurs.
- How to read a star chart.

GALAXIES & THE UNIVERSE
- How the Universe is believed to have formed.
- The Universe appears to be expanding.
- Possible fates of the Universe.

Students will be able to…

MOON
- Make an accurate model of the relative size and separation distance of the Earth and Moon.
- Describe and model the difference between phases and eclipses.
- Explain how the Moon was formed.
- State various ways the Moon affects our life on Earth.

SOLAR SYSTEM
- Make an accurate model of the relative sizes and separation distances of the Sun and 8 planets of the solar system.
- Explain how planets were formed.
• Describe the differences between the terrestrial and jovian planets.
• Define a planet and explain why Pluto is no longer considered to be one.
• Explain how asteroids and comets were formed and how they can give us more information about the early Solar System.
• Use Kepler’s laws to predict future planetary positions.

STARS
• Describe the cycle of stellar evolution for low and high mass stars.
• Use an H-R diagram to obtain data about a star.
• Explain the balance of forces required for a star to maintain controlled fusion during its main-sequence stage.
• Use the process of sampling to estimate larger totals.
• Use the coordinates of Right Ascension and Declination to read a star chart.

GALAXIES & THE UNIVERSE
• Explain the Big Bang Theory.
• Describe possible fates of the Universe.

Assessment

Formative assessment(s)...
• Readings with comprehension questions
• Quizzes
• Tests
• Activities/Labs
• Modeling Projects (group and individual)
• Research Projects (group and individual)

Summative assessment(s)...
• Final exam at the end of the semester

21 Century Connections

Cross Curricular
• Historical: The growth and evolution of our space program, specifically NASA missions over the last 50 years.
• Mathematical: Use of mathematical tools to describe the interaction and movement of astronomical bodies.

Character Education
• Honesty: Students are expected to report data honestly and in its entirety when doing work. Students are expected to adhere to the integrity code of the high school.
• Respect: Students are expected to be respectful and tolerant of differing points of view when working together in group settings.
- Responsibility: Students are expected to use all lab equipment and materials in an appropriate and safe manner, as per the science department’s safety contract.
Career
As per the NJCCCS:

9.1.B
Students will communicate and comprehend written and verbal thoughts, ideas, directions and information relative to educational and occupational settings. Students will select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.

9.2.A
Students will apply communications and data analysis to the problem-solving and decision making processes in a variety of life situations. Students will describe and apply constructive responses to criticism. Students will apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings. Students will recognize bias, vested interest, stereotyping, and the manipulation and misuse of information while formulating solutions to problems that interfere with attaining goals.

9.2.C
Students will model interpersonal and effective conflict resolution skills. Students will communicate effectively in a variety of settings with a diverse group of people.

9.2.D
Students will discuss consequences and sanctions when on-the-job rules and laws are not followed.

9.2.F
Students will engage in an informed discussion about rules and laws designed to promote safety and health. Students will analyze the occurrence of workplace hazards. Students will practice the safe use of tools and equipment. Students will implement safety procedures in the classroom and workplace, where appropriate.

Technology
As per the NJCCCS:

8.1.12.A.2
Students will produce and edit a multi-page document for a commercial or professional audience using desktop publishing and/or graphic software.

Course Outline and Suggested Pacing Guide:

COURSE INTRODUCTION (1 block):
- First day of school activities
- General overview of course
- Cosmic Calendar activity

THE MOON (12 blocks):
- Moon/Earth Play-doh models
- Moon formation theories
• Video “If We Had No Moon”
• “Lost on the Moon” test
• Standard Deviants Moon video clip
• Moon notes
• Moon research project and presentations
• Moon Landing Hoax lesson (conspiracy theory/mythbusters)
• Moon reading and comprehension questions
• Apollo Missions overview
• NASA lunar rocks/meteorites lesson
• Moon review game and test

THE SOLAR SYSTEM (12 blocks):
• Planet definition article
• Planet Play-doh models
• Standard Deviants Solar System video clip
• Solar System notes
• Introduce a planet to the class (“Nametag”)
• Scale distance drawing of the Solar System
• Age/Weight on other planets
• Kepler’s Laws graphing lab
• Standard Deviants “Other Stuff” video clip
• Solar System reading and comprehension questions
• Solar System Walk (scale size and distance)
• Planet research project and presentations
• Solar System review game and test

THE STARS (12 blocks):
• Introduction to stars worksheet
• Bill Nye “The Sun” video
• Star birth article
• Star Life Cycle Pictures and notes
• Star Life Cycle article
• Out of Order Evolution activity
• Star Types handouts and questions
• Stellar Evolution reading and comprehension questions
• Star Terms quiz
• Black Holes Myth vs. Fact
• Types of Black Holes handout
• Stargate video with questions
• Constellation Chart lab
• 3-D Constellation building project
• Star Sampling lab
• Stellar Evolution review game and test

GALAXIES & THE UNIVERSE (6 blocks):
• Contact movie with questions
• Topics in modern Astronomy research project
FINAL EXAM (2 blocks):
- Review for final exam
- Take final exam
Biochemistry II

Overview:

Biochemistry II is a lab-based course designed to allow students who are successful in Biology I to continue to learn about the living world. The main objective of this course is to show how adaptations allow for increased organism complexity and diversity. Biochemistry II is taught in two sections. The first half of the year focuses on the study of plants (botany). Students will be required to grow and maintain plant specimens and will frequently use microscopes to make scientific drawings. The second half of the year will focus on the study of animals (zoology). Students should be aware that specimen dissection is a major component to the zoology section of the course. Lab work may include modeling as well as actual work with plants and animals. This course will be assessed by a variety of methods that will include, but not be limited to, activities, tests, presentations, laboratory work and homework.
Philosophy:
This elective lab based course has been designed to provide students of all academic levels and abilities with a better understanding of living organisms and to build upon the concepts learned in Biology 1. The course will be divided into two sections. The first section will focus on the study of plants (botany) and the second section will focus on the study of animals (zoology). The main objective of this course is to show how adaptations allow for increased organism complexity and diversity.

The first section of the course focuses on the study of botany. Topics include: classification, the origin and diversity of plants, an overview of plant structure and function, energy transport and growth in plants, plant response and reproduction, and the ecological roles of plants. Students will be required to grow and maintain plant specimens and will frequently use microscopes to make scientific drawings.

The second section of the course will focus on the study of zoology. Topics include basic characteristics of animals, characteristics of several phyla of the animal kingdom, the evolutionary changes that have occurred between the phyla, and the ecological roles of animals. Students should be aware that specimen dissection is a major component to the zoology section of the course.

Textbook:
The Web of Life by Strauss and Lisowski, Pearson/SFAW

Other Resources:
Support materials provided with the text
Lab manual handouts from several sources
Teacher-prepared worksheets and lab procedures

Field Trips:
Experience away from the classroom can include the following, but are not limited to this list.
1. Pine Barrens
2. Island Beach State Park
3. Environmental Protection Agency
4. Sandy Hook State Park
5. Shark River
6. Eco Center at Rutherford
7. Museums
8. Zoos
9. Aquariums
10. State Forests
11. Local Farms
12. Marshland

Equipment:
Plant and Animal models
Specimen from each of the major phyla (Living and preserved)
Dissection specimens
In-class Habitats (Field, Forest, River…)
Course provided Log Books
Greenhouse
New Jersey Science Standards:

The following is a list of standards covered in this course content.

5.1
5.1.12.C.1, 5.1.12.C.2

5.2
5.2.12.B.3

5.3
5.3.12 A.1, 5.3.12.A.4
5.3.12.B.1, 5.3.12.B.4
5.3.12.C.1
5.3.12.D.2
5.3.12.E.1, 5.3.12.E.2, 5.3.12.E.3, 5.3.12.E.4

5.1 Science Practices:
All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

A. Understand Scientific Explanations:
Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.
5.1.12.A.1 Refine interrelationships among concepts and patterns of evidence found in different central scientific explanations.
5.1.12.A.2 Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories.
5.1.12.A.3 Use scientific principles and theories to build and refine standards for data collection, posing controls, and presenting evidence.

B. Generate Scientific Evidence Through Active Investigations:
Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.
5.1.12.B.1: Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/correlational relationships, and anomalous data.
5.1.12.B.2: Build, refine, and represent evidence-based models using mathematical, physical, and computational tools.
5.1.12.B.3: Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories.
5.1.12.B.4: Develop quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations.
C. Reflect on Scientific Knowledge: Scientific knowledge builds on itself over time.
5.1.12.C.1: Reflect on and revise understandings as new evidence emerges.
5.1.12.C.2: Use data representations and new models to revise predictions and explanations.

D. Participate Productively in Science:
The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.
5.1.12.D.1: Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences.
5.1.12.D.2: Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.
5.1.12.D.3: Demonstrate how to use scientific tools and instruments and knowledge of how to handle animals with respect for their safety and welfare.

5.2 Physical Science:
All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

B. Changes in Matter:
Substances can undergo physical or chemical changes to form new substances. Each change involves energy.
5.2.12.B.3: Balance chemical equations by applying the law of conservation of mass.

D. Energy Transfer and Conservation:
The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.
5.2.12.D.2: Describe the potential commercial applications of exothermic and endothermic reactions.
5.2.12.D.5: Model the change in rate of a reaction by changing a factor.

5.3 Life Science:
All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

A. Organization and Development:
Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.
5.3.12.A.1: Represent and explain the relationship between the structure and function of each class of complex molecules using a variety of models.
5.3.12.A.4: Distinguish between the processes of cellular growth (cell division) and development (differentiation).

B. Matter and Energy Transformations:
Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.
5.3.12.B.1: Cite evidence that the transfer and transformation of matter and energy links organisms to one another and to their physical setting.
5.3.12.B.4: Explain how environmental factors (such as temperature, light intensity, and the amount of water available) can affect photosynthesis as an energy storing process.

C. Interdependence:
All animals and most plants depend on both other organisms and their environment to meet their basic needs.

5.3.12.C.1: Analyze the interrelationships and interdependencies among different organisms, and explain how these relationships contribute to the stability of the ecosystem.

D. Heredity and Reproduction:
Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

5.3.12.D.2: Predict the potential impact on an organism (no impact, significant impact) given a change in a specific DNA code, and provide specific real world examples of conditions caused by mutations.

E. Evolution and Diversity:
Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

5.3.12.E.1: Account for the appearance of a novel trait that arose in a given population.

5.3.12.E.2: Estimate how closely related species are, based on scientific evidence (e.g., anatomical similarities, similarities of DNA base and/or amino acid sequence).

5.3.12.E.3: Provide a scientific explanation for the history of life on Earth using scientific evidence (e.g., fossil record, DNA, protein structures, etc.).

5.3.12.E.4: Account for the evolution of a species by citing specific evidence of biological mechanisms

Enduring Understanding(s):
- Plants and animals have importance in our daily lives.
- Uses of plants and animals vary by location and culture.
- Plants and animals are interrelated.
- There is diversity of life.
- Reproduction of organisms is necessary for the perpetuation of species
- The great diversity of organisms known to exist in our biosphere has required a thorough system of classification. This system has been refined to correspond with new knowledge and discoveries.
- The diversity of life is the result of ongoing evolutionary change. Species alive today have evolved from ancient common ancestors.
- From microorganisms to plants, organisms vary widely in the way they carry out basic life processes.
- Animals have evolved diverse ways to carry out basic life processes and maintain homeostasis.

Objectives
Students will
- Acquire an understanding of the importance of plants and animals in our daily lives.
- *Be able to understand the cultural uses of plants and animals used locally.
• Develop knowledge of the life-cycle, reproductive, structural, chemical, evolutionary, and anatomical characteristics of plants and animals.
• Describe the characteristics of each of the major phyla.
• Sketch the life cycle for each of the major phyla.
• Acquire a basic knowledge of physiology, ecology, and ethnobiology.
• Learn the diversity and classification of organisms.
• Understand the interrelationships of plants and animals and their environment.
• Identify the local species of plants and animals.
• Enhance environmental and ecological understanding and awareness.
• Investigate career opportunities related to botany and zoology.

Knowledge & Skills:

The following is a list of objectives being taught in Biology II.

1. Classification of Organisms - Students will be able to:
   • Describe the Carl von Linne system used to classify organisms
   • Define the term taxonomy
   • Define and use all five levels on von Linne's classification: kingdom, phylum, class, order, family, genus, and species
   • Use binomial nomenclature to identify organisms.
   • Relate phylogenetic trees to evolutionary relationships.
   • Demonstrate the applications of and write a dichotomous key.

2. Natural history of Plants - Students will be able to:
   • Compare and contrast the characteristics of the divisions of modern plants.
   • Identify the characteristics used to classify different plants.

3. Characteristics of the Life Cycle of Mosses - Students will be able to:
   • Compare and contrast the haploid and diploid stages of moss reproduction.
   • Draw and properly label the reproductive structures of Polytricum from prepared slides.

4. Characteristics and Life Cycle of Ferns - Students will be able to:
   • Identify the common characteristics of ferns.
   • Compare the haploid and diploid stages of the fern life cycle.
   • Identify the differences between the life cycles of ferns and mosses.

5. Characteristics and Life Cycles of the Conifers - Students will be able to:
   • Identify the common characteristics of conifers.
   • describe the life cycle of conifers.
   • Describe the differences between pollination and fertilization.

6. Flowering plants, Monocots and Dicots, Flower Anatomy - Students will be able to:
   • Define the term angiosperm.
   • Identify the common characteristics of flowering plants.
   • Identify the characteristics of Monocots and Dicots.
• Determine whether plant samples are from Monocots or Dicots based on characteristics.
• Identify the male, female, and sterile parts of a flower.
• Perform a flower dissection and label all the parts accordingly.

7. Angiosperm Life Cycle, Pollination, Seed Production, and Seed Dispersal - Students will be able to:
• Create a diagram describing all the life cycle of angiosperms with descriptions.
• Describe the strategies flowering plants have developed to increase pollination.

8. Structure of Plants - Students will be able to:
• Identify the main structures of leaves, stems, and roots.
• Compare the main functions of leaves, stems and roots.
• Compare the three types of plant tissues: dermal, vascular, and ground tissues.
• Prepare drawings of Monocot and Dicot leaves, stems and roots, and be able to label the types of tissues found in each.

9. Seed germination - Students will be able to:
• Identify the basic parts of seeds and plant embryos.
• Define the term germination and identify three factors that control germination.
• Describe the events that occur in the process of seed germination.
• Design and run an experiment to observe and measure the rate of seed germination.

10. Transport in Stems - Students will be able to:
• Compare and contrast the structures and functions of xylem and phloem.
• Define transpiration and its role in moving water up through plant tissue.
• Describe the pressure-flow hypothesis and how it is responsible for moving sugars within plants.

11. Leaf Anatomy Stomates - Students will be able to:
• Describe the internal and external structures of leaves.
• Describe the functions of the following structures: cuticle, epidermis, mesophyll, stoma, guard cells.
• Describe the movement of guard cells around stoma when leaves are exposed to different solutions.

12. Photosynthesis - Students will be able to:
• State the three items needed for plants to undergo photosynthesis.
• Identify the three basic parts of the chloroplast and state what occurs in each section.
• Identify several pigments found in plants, describe their roles in light absorption and explain why many plants look green.
• Write the balanced chemical equation of photosynthesis and state the sources of the reactants and the final uses of the products.
• Compare and contrast the light dependent and light independent reactions of photosynthesis.

13. Plant Growth and Development - Students will be able to:
• Describe where cells and tissues develop in plants.
• Compare and contrast the two patterns of plant growth.
• Define the following terms: meristem, primary growth, secondary growth, and cambium.
14. Plant Responses to the Environment - Students will be able to:
   - Define the term stimulus and describe how plants respond to various stimuli.
   - Define the term tropism and be able to describe photo-, thigmo-, and gravitropism.
   - Explain the differences between positive and negative tropisms and the adaptive value of each.
   - Describe the role that different plant hormones play in plant growth and development.

15. Introduction to Animals - Students will be able to:
   - Distinguish the animal characteristics from those of other animals.
   - Describe functions necessary for animal survival.
   - Describe the first stages of animal embryo development.
   - Identify the major milestones in the evolution of animals.

16. Introduction to Mollusks - Students will be able to:
   - Describe the basic characteristics of mollusks.
   - Identify several animals as mollusks.
   - Describe the characteristics of the four classes of mollusks.
   - Observe the several preserved mollusk specimens and shells and list observations and similarities between them and identify the class of each.

17. Annelids (Segmented Worms) - Students will be able to:
   - Define and use the terms to describe symmetry: dorsal, ventral, anterior, and posterior.
   - Identify the characteristics and organ systems of segmented worms.
   - Compare and contrast the three classes of segmented worms.
   - Determine the major phyla traits for earthworms based on observations while dissecting a preserved earthworm.
   - Identify organs of the major systems while using an earthworm "map".
   - Label the organs of an earthworm on a diagram.

18. Introduction to Arthropods - Students will be able to:
   - Describe the characteristics all arthropods share.
   - Describe the characteristics of the three subphyla of arthropods.
   - Build a fictional arthropod of one of the subphyla with all of the correct characteristics.

19. Crustacean Diversity, Internal and external Anatomy - Students will be able to:
   - Describe the different groups of crustaceans based on their characteristics.
   - Identify the external structures of a crayfish and describe their uses.
   - Define the cephalization and explain its importance in evolution.
   - Identify the internal organs of the crayfish and describe their uses.
   - Dissect a preserved crayfish and identify various structures.

20. Chelicerates (spiders and their relatives) – Students will be able to:
   - Describe the common characteristics and structures of chelicerates.
   - Compare the characteristics of spiders and ticks.
   - Prepare a drawing of a preserved tick and describe the adaptations that allow it to survive.
21. Insects and their Relatives (Uniramians) and Metamorphosis – Students will be able to:
   - Describe the basic characteristics of Uniramians.
   - Identify the three classes of Uniramians (chilopoda, diplopoda, and insecta) and some of their characteristics.
   - Distinguish between complete and incomplete metamorphosis and the stages of each.
   - Make observation of preserved locust and mosquito specimens and recognize adaptations that allow them to be successful.

22. Echinoderms (sea stars and urchins) – Students will be able to:
   - Describe the skeletal, digestive, vascular, and reproductive systems of the sea star.
   - Differentiate between sea stars (class Asteriodia) and sea urchins (class Echinoidea).
   - Dissect a starfish and identify the parts of the major organ systems.

23. Characteristics and Diversity of Vertebrates, Characteristics and Diversity of Fish – Students will be able to:
   - Describe the characteristics of vertebrates.
   - Define the terms endotherm and ectotherm and explain the differences between the terms.
   - Explain how the adaptations and characteristics of fish allow them to survive in their environments.
   - Perform a dissection and identify the internal and external structures of fish.
   - Conduct an experiment to determine how environmental temperature affects the respiration rate of fish.
   - Compare and contrast the different classes of fish.

24. Amphibians – Students will be able to:
   - Explain the evolutionary steps that led to modern amphibians.
   - Describe the adaptations that allow amphibians to survive in their environment.
   - Perform a frog dissection and identify the important structures of frog anatomy.
   - Summarize the life cycle of typical amphibian.
   - Explain the importance of amphibians for monitoring conditions in the environment as bio-indicators.

25. Characteristics and Diversity of Reptiles/Structures of the Amniotic Egg – Students will be able to:
   - Describe the major characteristics of reptiles.
   - Describe the importance of the amniotic egg.
   - Observe an egg and identify the important structures.
   - Compare and contrast the different classes of reptiles.

26. Characteristics and Diversity of Birds – Students will be able to:
   - Explain the structural adaptations that allow birds to fly.
   - Summarize the life cycle of a typical bird.
   - Summarize the differences between birds and other vertebrates.
   - Analyze the evidence for the evolutionary origin of birds.

27. Characteristics and Diversity of Mammals – Students will be able to:
• A. Identify the characteristics of mammals.
• Compare and contrast monotremes, marsupials, and placental mammals.
• Compare the three orders of mammals and describe characteristics of several separate classes of mammals.
• Perform a mammal dissection and be able to identify the important aspects of mammal anatomy.
Activities & Assignments

Classification of Organisms
Shark dichotomous key lab
Designing a dichotomous key for leaves

Natural history of plants – mosses, ferns, conifers
Observations of live mosses and prepared slides
Observations of live fern life cycle and prepared slides
Venn diagram to compare mosses and ferns
Field observations of conifers

Flowering plants, monocots/dicots, flower anatomy
Monocot/dicot lab practical
Flower anatomy/dissection

Angiosperm life cycle, pollination, seed production and seed dispersal
Angiosperm life cycle cut and paste
Fruit and seed lab
Seed dispersal lab
Video: “The Seedy Side of Plants”
Videos: “Private Life of Plants” Part 1
           “Private Life of Plants” Part 3 “Flowers: Birds and Bees”

Structure of Plants
Observation of stem, root, leaf tissue slides/specimens
Identification of dermal, vascular, ground tissue
Observation of root hairs

Seed germination
Fast plants germination lab
Student Designed Experiment: Factors that affect seed germination

Transport in Stems
Transpiration Lab

Leaf Anatomy
Observation of leaf anatomy slides and specimens
Factors that control opening of stomates lab

Photosynthesis
Observations of chloroplasts in Elodea cells
Plant pigment chromatography
Lab 9: Energy Flow and Photosynthesis

Plant growth and development
Observation and data collection of fast plant growth
Dendrochronology (tree ring analysis) activity
Plant Responses to the Environment
Lab: Observing tropisms in growing plants
Lab: The effect of gibberellin on plant growth

Introduction to animals
Determination of essential life functions
Concept map of animal characteristics

Mollusks
Observations of preserved specimens and shells
Identification of classes and characteristics
Video: “Nature: The Octopus Show”

Annelids (segmented worms)
Listing and use of anatomical terms
Chart of Worm characteristics
Earthworm dissection
Drawings and observations of leech slides
Video: “The Bite That Heals”

Introduction to Arthropods
List common characteristics from preserved specimens and slides
Student definitions of arthropods
Build a new arthropod
Research paper on insects as vectors for disease

Crustacean Diversity, Internal and External Anatomy
Crayfish dissection

Chelicerates
Tick slide observations – listing of tick adaptations

Insects and their Relatives and Metamorphosis
Locust Observations
Mosquito life cycle slide observation

Echinoderms
Starfish dissection and characteristics packet
Tube feet slides and drawings
Guided notes and Critical thinking Exercise

Characteristics and Diversity of Vertebrates, Fish
“Life in the Water” worksheet
Perch dissection
Fish respiration lab

Amphibians
Frog dissection
Frog life cycle worksheet
Articles on frogs as bio-indicators and frog deformities
Characteristics and Diversity of Reptiles/Structures of the Amniotic Egg
Reptile newsflash worksheet
Video “The World of Reptiles”

Characteristics and Diversity of Reptiles/Structures of the Amniotic Egg
Reptile newsflash worksheet
Video “The world of reptiles”

Characteristics and Diversity of Birds
Egg observation lab/Chick development

Characteristics and Diversity of Mammals
Mammal lesson project
Rat dissection

Assessment

May include the following but are not limited to:
1. Presentations: multimedia/oral
2. Writing component
3. Lab exams, practicals
4. Collections, leaves/insects
5. Laboratory log book
6. Classic standard assessment

See Activity/Skills Assessed chart that follows.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Skills Assessed</th>
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</thead>
<tbody>
<tr>
<td>Create a Dichotomous Key</td>
<td>Observation, classification</td>
</tr>
<tr>
<td>Microscope Labs</td>
<td>Observation, plate drawing</td>
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<tr>
<td>Fern Lap Practical</td>
<td>Observation, compare/contrast, written descriptions</td>
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<tr>
<td>Plant Concept Mapping</td>
<td>Organization, making connections between various topics</td>
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<tr>
<td>Lab Practical: monot vs dicot plants</td>
<td>Observation, compare/contrast, written descriptions</td>
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<tr>
<td>Flower Dissection</td>
<td>Dissecting skills, observations, drawing, written descriptions</td>
</tr>
<tr>
<td>Fruit and Seed Lab</td>
<td>Compare/contrast, written descriptions, scientific drawing</td>
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<tr>
<td>Seed Germination Experiment</td>
<td>Designing experiments, full written lab report including data evaluation and analysis</td>
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<tr>
<td>Transpiration Rates</td>
<td>Massing and measuring, observing, performing calculations and data analysis</td>
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<tr>
<td>Observation stomata and guard cells</td>
<td>Observation, plate drawing, interpreting</td>
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<tr>
<td>Activity</td>
<td>Observation/Activity Details</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>Dendrochronology Lab</td>
<td>Observations, calculations, interpreting observations and data</td>
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<tr>
<td>Pigment Chromatography</td>
<td>Observations, calculations, interpreting data</td>
</tr>
<tr>
<td>Energy Flow in Photosynthesis</td>
<td>Observations, weighing and measuring, full written lab report including data analysis and conclusions</td>
</tr>
<tr>
<td>Observing tropisms in growing plants</td>
<td>Observations, interpreting data, writing conclusions</td>
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<tr>
<td>Specimen dissections (worm, crayfish, starfish, perch, frog, rat)</td>
<td>Dissecting skills, scientific drawing, compare/contrast between organisms</td>
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<tr>
<td>Build an arthropod</td>
<td>Interpreting information, compare/contrast</td>
</tr>
<tr>
<td>Effects of temperature on fish respiration</td>
<td>Observations, data collection calculations, graphing (full lab report)</td>
</tr>
<tr>
<td>Chicken/egg observations; check development</td>
<td>Observation, interpreting data</td>
</tr>
<tr>
<td>Mammal Lesson Project</td>
<td>Topic research, presentation skills</td>
</tr>
</tbody>
</table>

**21 Century Connections:**

**Cross Curricular:**

1. Students will be required to build on the knowledge already acquired in prerequisite courses of Biology.
2. During this course students are required to perform mathematical analysis on data to develop valid and supported conclusions during scientific experiments.
3. Students are required to evaluate and analyze many situations that give them a historical perspective on biological issues.

**Character Education:**

Students will be required to complete all tasks and assignments in accordance with the Academic Integrity policies of South Brunswick High School.

**Career:**

Standard 9.1 (Career and Technical Education) All students will develop career awareness and planning, employability skills, and foundational knowledge necessary for success in the workplace.

**B. Employability Skills:**

- Select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.
- Demonstrate teamwork and leadership skills that include student participation in real world applications of career and technical education skills.
Standard 9.2 (Consumer, family, and life skills) All students will demonstrate critical life skills in order to be functional members of society.

A. Critical Thinking
   Apply communications and data analysis to the problem solving and decision making processes in a variety of life situations.
   Apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.
   Recognize bias, vested interest, stereotyping, and the manipulation and misuse of information while formulating solutions to problems that interfere with attaining goals.

F. Safety
   Engage in an informed discussion about rules and laws designed to promote safety and health.
   Practice the safe use and tools and equipment.
   Implement safety procedures in the classroom and workplace, where appropriate.

Technology:
Strand F: Critical Thinking, Problem Solving and Decision Making

8.1.12.F.1: Select and use specialized databases for advanced research to solve real world problems.

Course Outline for Biology II
The following is a detailed list of topics that will be taught during the Biology II course:

Classification (Chapter 13)
- Grouping organisms, kingdoms, naming organisms (13.1)
- Phylogenic trees (13.2)
- Dichotomous keys (13.3)

Origin and Diversity of Plants (Chapter 20)
- Natural history of plants (20.1)
  - Ancestors of green algae
  - Divisions of plants
    - Non-vascular plants: mosses, liverworts, hornworts
    - Vascular plants: seedless and seeded plants
      - All have root stems and leaves: ferns, gymnosperms, angiosperms
- Mosses (20.2)
  - Characteristics of mosses
    - Non-vascular: no roots or leaves (have rhizoids)
    - Habitat: need water for reproduction
  - Moss life cycle
    - Gametophyte: produces egg and sperm
      - Male: antheridium
      - Female: Archegonium
    - Capsules: Production of spores
Role of mosses: decomposers prevent water and soil loss, shelter, nesting materials, fuels

Ferns (20.3)
Characteristics of ferns:
- Largest group of seedless plants
- Habitat: requires moist area for reproduction
- Vascular: Have true leaves/stems/roots

Fern life cycle:
- Sporophyte stage: typical with roots/stems/leaves
- Have sorus: underside of leaves that produce spores
- Sporophytes produce gametophytes: similar to mosses

Role of ferns:
- Ecological succession, food, nitrogen fixation, horticulture

- Conifers (20.4)
Characteristics of conifers:
- Vascular plants
- Bear cones
- Needle-like leaves (evergreens): less transpiration
- Gymnosperms: produce seeds in cones, male and female cones, “naked seeds” (not enclosed in fruit)

Conifer life cycle:
- Both sporophyte and gametophyte stages
- Differences in male and female cones
- Pollination: growth and development of sporophyte

Role of Gymnosperms
- Ecological: needles provide year-round share, decompose slowly, provide acidic humus, provide animal shelter
- Economical: lumber, ornamental

- Flowering Plants (20.5)
Characteristics of Flowering Plants (angiosperms)
- Flowers
- Leaves, stems, roots with vascular tissue
- Woody or non-woody stems
- Gametophytes grow within the sporophyte
- Sexual reproduction dependent on air and organisms
- Seeds
- Double fertilization
- Fruit

Monocots vs. Dicots
- Number of cotyledon (seed leaves)
- Arrangement of vascular tissue and flowering structures

Angiosperm life cycles
- Sporophytes into gametophytes
- Pollination and fertilization
- Flowers
- Production of fruit

Sexual reproduction in plants (19.4)
- Advantages of sexual reproduction
- Alternation of generations: gametophyte and sporophyte generations
- Production of seeds: monocots and dicots
- Seed dispersal: Adaptations to spread seeds
- Germination: sprouting of seeds based on water and temperature
Flowers (19.5)

Structure of flowers
Male: stamens: anthers/filaments/pollen
Female: Pistil: eggs/ovary/ovule
Pollination/Fertilization/seed production

Life spans (17.4)
Annuals, biennials, perennials

Overview of Plant Structure and Function (Chapter 17)

Plants are multi-cellular eukaryotes. Cells contain cell walls and chloroplasts.
Plants are autotrophs: can produce their own food using the energy from sunlight.
The structure of plants (17.1)
Three types of plant tissue: dermal, vascular, ground

Leaves:
Area of photosynthesis: chlorophyll contained in chloroplasts
Blades, veins, petiole
Simple and compound leaves
Monocot and Dicot leaves

Stems:
Support of leaves and flowers
Nodes: where leaves attach to the stem
Phloem: transport sugars from leaves down to the rest of plant
Xylem: transport water and minerals up from soil to leaves
Categories:
Herbaceous: non-woody with thin tissue and protective layers
Shrub/tree: have trunk, branches and twigs
Vines: Slender, woody stems supported by other plants

Roots:
Usually grow below ground
Absorb water and minerals
Made of root tips and root hairs: increase surface area
Anchor plant to the ground
Two types of roots:
Tap roots: large central root with smaller roots branching off

Flowers, fruits, seeds:
Flower: reproductive structures of flowering plants. Produce pollen and eggs
Pollination: transporting of pollen from male to female flower parts
Seed: reproductive structure consisting of plant embryo and food
Fruits: house and protect seeds and may help in seed dispersal

Energy Transport and Growth in Plants (Chapter 18)

Photosynthesis in Plants (18.1)
Leaves are site of P.S.
Anatomy of Leaves: Cuticle, upper epidermis, veins, mesophyll (area of chloroplast), lower epidermis
Stomata and guard cells
Mesophyll: area of P.S.
Three requirements for P.S.: light, water, carbon dioxide
Chloroplast structure and function: grana, stroma, thylakoids (4.2)
The role of chlorophyll and pigment chromatography
The chemical equation of photosynthesis: the source of reactants and the uses of the products
The light dependent and light independent (Calvin cycle) reactions of photosynthesis

- Transport in Plants (18.2)
  Transport in Roots
  Root structure: epidermis, root hairs, cortex, endodermis, phloem, xylem
  Absorption of water and minerals
  Factors that control absorption: water and oxygen in the soil, bacteria, decomposers (fungi)
  Transport in Stems
  Xylem: water and minerals from soil to leaves
  Tracheids and vessel elements
  Phloem: Transports sap up and down within the plants
  Sieve tube elements and companion cells
  Transpiration: movement of water upward in the plant against gravity.
  Transport in Leaves
  Vascular tissue called veins
  Water moves through transpiration
  Sugars move via the “pressure-flow hypothesis”

- Plant Growth (18.3)
  Meristems: growing tissues of plants. Produces new cells through mitosis.
  Apical and axillary meristems
  Primary growth: elongation of stems and roots
  Secondary growth: roots, stems and branches grow wider
  Lateral meristem (cambium)
    Vascular cambium, cork cambium, structure of wood (growth rings)

- Response and reproduction in plants (Chapter 19)
  Plants responding to the environment (19.1)
  Typical plant responses: Stimulus
  Tropisms: growth in a direction in response to a stimulus
    Photo-
    Gravi-
    Thigmo-
  Nastic Movements: movements responding to any stimulus
    Short-term reversible changes (Venus flytrap leaves)

- Plant Hormones (19.2)
  Chemicals that control plant growth and responses. Organic compounds produced in small amounts and released by one part of the plant but used by another part.
  Examples: Auxins, gibberellin, ethylene, cytokinin, abscisic acid

- Asexual reproduction in plants (19.3)
  Vegetative Reproduction: advantages and disadvantages
  Artificial propagation: used by people to produce new plants (grafting cuttings, tissue cultures)

Introduction to Animals (Chapter 21)
• Characteristics of animals (21.1)
  Eukaryotic, multicellular, heterotrophs, cells lack cell walls.

Essential Life Functions:
  Support and movement
  Energy and removal of wastes
  Respiration
  Sensing the Environment
  Reproduction

Diversity in Animals: Development of animal embryos.
  Zygote forms a blastula
  Blastula forms into a two-layered (or three-layered) cup-like call of cells called a gastrula.
  Inner layer is endoderm – develop into digestive and respiratory systems.
  Outer layer is the ectoderm – develops into skin, sense organs, and nerves.
  Middle layer is the mesoderm: muscle, circulatory, reproductive, and excretory systems.

Four basic evolution milestones:
  Formation of tissues: parts of animals become specialized for different functions.
  Body symmetry: animals with true tissues were arranged around a central point or plane.
  Body cavities partially lined with tissues, formed from the embryonic mesoderm.
  Formation for the blastopore: embryonic opening that forms either the mouth or the anus.

Vertebrates: animal with a backbone
Invertebrates: animals without a backbone.

Worms and Mollusks (Chapter 22)
• Characteristics of Mollusks (22.2)
  Mollusks: animals with soft body that is protected by one or more shells. Some have no shell.
  Mantle: soft outer tissue layer on all mollusks. Will secrete the shell if present.
  Mantle cavity: internal chamber that houses respiratory structures.
  Muscular foot: used for locomotion or attachment.
  Visceral mass: contains most organs such as heart, gonads and stomach.
  Most but not all have open circulatory systems: blood enclosed in some areas of the body, but leaves vessels and bathes organs. Heart pumps blood into open-ended vessels.
  Digestive tract with two openings.
    Filter feeders, herbivores with special mouthparts, predatory with beak-like mouths.
  Most have simple nervous systems. Squid and octopus have complex nervous systems with large eyes and acute senses.
  All reproduce sexually: either internal or external fertilization.
  Mollusk diversity: classes
    Gastropoda: mollusks with shells, such as snails and conches. Slugs that lack a shell. Have radula. More complex nervous system. Aquatic have gills, terrestrial have mantle cavity for gas exchange.
    Bivalvia: clam, mussel, scallop, oysters. Two shells attached by a hinge.
Filter Feeders
Cephalopoda: nautiluses, cuttlefishes, squids, octopuses. Highly developed nervous systems. Closed circulatory system – blood travels in a continuous system of vessels.

Role in the environment:
- Used as food source, monitor environmental conditions, potential sources for medicines, consume crops, destroy boats and docks made of wood.
- Zebra mussel’s invasion of Lake Erie.

- Characteristics of segmented worms. (22.3)
  Annelids: wormlike animals whose bodies are made of segments (earthworms, leeches, wormlike animals).
  True coelomates: body cavity lines with mesoderm.
  Setae: small bristles for movement.
  Well-developed nervous system with specialized sense organs.
  Nephridia: tubes used to excrete wastes.
  No respiratory structures, gas exchange through the skin.
  Some reproduce asexually by regeneration, most are sexual. Some have separate sexes but many are hermaphroditic: have both male and female reproductive systems.
  Annelid diversity: Classes
  Polychaeta: free-living or tube-dwelling marine worms.
  Oligochaeta: earthworms and other terrestrial worms, some marine and freshwater worms.

Role in environment:
- Important to food chains. Earthworms play important role in plant growth.
- Leeches used for bloodletting.

Anthropods (Chapter 23)
Phylum Arthropoda is the most diverse animal phylum
- Characteristics of Arthropods (23.1)
  Segmented body parts fused in larger body regions]
  Jointed appendages
  Exoskeletons made of chitin
  Extensive muscular system
  Central nerve chord and brain
  Open circulatory system
  Gills or tracheal tubes for gas exchange
  Compound eyes
  Phylogenetic tree of Arthropoda
  Crustacea: legs with claws, chewing mouthparts, two pairs of antennae
  Chelicerata: pincher-like mouthparts, no antennae
  Uniramia: chewing mouthparts, one pair of antennae, no claws.

- Characteristics of crustaceans (23.2)
  Cephalothorax
  Mandibles: one pair of jaw-like appendages
  Maxillae
  Maxillipeds
  Claws
  Walking legs
  Abdomen
  Swimerettes
Telson and uropods: used for swimming

Crustacean diversity
- Decapods
- Isopods
- Cerripeds

- Characteristics of chelicerates (23.3)
  - Cephalothorax and abdomen
  - No sensory antennae
  - Have simple eyes, not compound eyes
  - Anterior-most appendages called chelicerae modified into fangs for killing prey. Some inject poison.
  - Structure for water-retention
    - Malphigian tubules: remove wastes from blood, return water to cells.
    - Exoskeleton: prevents water loss.
    - Book lungs: allows for gas exchanges without water loss.

- Classes of chelicerates
  - Meristomata: horseshow crabs
  - Arachnida: cephalothorax with six pairs of appendages: one pair of chelicerae, one pair of pedipalps, sex pairs of walking legs
  - Spiders, scorpions, mites, ticks

- Characteristics of uniramians (23.4)
  - Single pair of antennae
  - Unbranched appendages
  - Complex digestive system with complex organs (crop, gizzard, hind gut, anus)
  - Malphigian tubules
  - Respiratory system through spiracles
  - Chilopoda: centipedes
  - Diplopoda: millipedes
  - Insecta: insects
    - Have three distinct body parts: head, thorax, abdomen
    - All have compound eyes; some have simple eyes as well
    - Three pairs of mouthparts
    - Three pairs of walking legs
    - Often go through metamorphosis
      - Incomplete: two stages (nymph and adult)
      - Complete: larvae, pupa, adult
    - Insect adaptations: communication, social behavior, mimicry

- Ecological roles of arthropods (23.5)
  - Food source for other organisms
  - Control plant growth and reproduction: control pollination
  - Vectors for disease: Lyme, malaria, plague, Rocky Mountain spotted fever
  - Food source for people
  - Control using pesticides: causes of pollution and environmental damage

Echinoderms (Chapter 24)

- Characteristics of Echinoderms (24.1)
  - Marine animals with spiny skin, an endoskeleton, radial symmetry, water vascular system.
  - Structures:
Sieve plate: opening in dorsal side where water enters and leaves
Ring canal: path around center of organism
Radial canal: water path down each radial arm
Ampulla: along radial canal, muscular sac that forces water into the tube foot.
Tube foot: hollow tube which may contain a suction cup at one end. Beneath each ampulla.
Reproductive, digestive, nervous and vascular systems extend through each arm.

Echinoderm diversity: different classes
Asteroidea: sea stars, scavengers or carnivores, sense food chemically.
Ophiuroidea: brittle stars and basket stars. Longer and thinner arms, more mobile than sea stars. Use arms for filter feeding, are also scavengers and carnivores.
Echinoidea: sea urchins and sand dollars. Sphere or disk-shaped bodies with no arms. Bodies covered with moveable spines. Feed by grazing, filtering sediment, or scavengers.
Holothuroidea: sea cucumbers. Lack arms and five part bodies. Have rows of tube feet lining the body. Filter plankton using tentacles.
Crinoidea: sea lilies and feather stars. Few species remain today but very common in the fossil record. Have mouth on the dorsal surface. Five or more arms with sticky feet used to filter plankton.

Fishes and amphibians (Chapter 25)
- Characteristics of Vertebrates (25.1)
  Vertebrates: animals with a backbone.
  Phylum: Chordata
  - Have a dorsal hollow verte chord: become the spinal chord and brain.
  - Notochord: becomes replaced by the backbone.
  - Gill slits or pouches: in aquatic animals develop into gills, in terrestrial animals they develop into other structures.
  - Post-anal tail: only characteristic, most keep throughout their lives.
  - Have endoskeleton: support more weight, grows with the organisms.
  - Have a distinct skull.
  - Closed circulatory system with a multi-chambered heart.
  - Ectotherms: temperature controlled by the environment.
  - Endotherms: control temperature by internal processes.

- Characteristics of Fisher (25.2)
  Anatomy: adaptations to living in the water
  - Swim bladder
  - Scales/mucous coat
  - Fins
  - Sensory organs: lateral line system, sense of smell
  - Gills for gas exchange
  - Opercula: gill covers
  - Single loop circulatory system and two-chambered heart.
  - Removal of wastes by kidneys: different for freshwater or saltwater fish.

- Origin and Diversity of Fishes (25.3)
  Classes of fishes:
  - Agnathans: jawless fish that may be the precursor of all other vertebrates.
  - Lampreys and hagfishes. Snakelike bodies without lobed fins. Feed as scavengers or parasites.
Chonrichthyes: sharks, rays and skates. Evolved in deep sea water. Possess bony jaws but a skeleton made of cartilage.

- Ecological role of fishes (25.4)
  Role in aquatic food chains.
  Use as human food source.
  Recreational: aquariums, sport fishing, scuba diving.
  Medical benefits of fish-rich diet.
  Used for livestock feed, pet foods, glue.

- Characteristics of Amphibians (25.5)
  Class Amphibia
  Vertebrate that is well-adapted to life in and out of the water. Must be able to support body on land, light and sound travel differently in air.
  Have two strong front limbs and two strong back limbs.
  Nervous system with brains, spinal chords and nerves.
  Sense organs work well in air and water.
    - Nictitating membrane on eyes.
    - Tympanic membrane on ears.
  Skin that stays moist for gas exchange.
  Internal lungs with air sacs that stay moist for gas exchange.
  Digestive tract: mouth, esophagus, stomach, small intestine, large intestine.
  Cloaca: common chamber that digestive, reproductive and excretory systems empty.
  Double-loop circulatory system and three-chamber heart. Heart separates the oxygenated from non-oxygenated blood.
  Kidneys remove water in water, conserve water on land.
  Amphibian life cycle: only vertebrates that go through metamorphosis (frogs)
  External fertilization of eggs.
  Eggs hatch into tadpoles.
  Triggered by hormone called thyroxine.
  Grows adult teeth and jaws, shorter digestive tract of carnivores, double loop three chambered heart from single loop, two chambered heart, gills disappear lungs form.

- Origin and diversity of Amphibians (25.6)
  Evolved from lobed-finned fishes with primitive lungs and legs.
  Orders of amphibians:
    - Anura: frogs and toads
    - Urodela: salamanders
    - Apoda: caecilians- worm-like amphibians adapted to burrowing in the soil.

- Ecological role of amphibians (25.7)
  Part of both aquatic and terrestrial food chains.
  Major factor controlling insect populations.
  Useful as bio-indicators of environmental pollution and global warming.

Reptiles (Chapter 26)

- Characteristics of reptiles (26.1)
  Characteristics that allow for the conservation of water and a land existence
  Dry, scaly skin holds in water
  Legs close to the body for easier movement on land.
  Most are carnivores.
Partially-divided three-chambered heart for better blood separation. Tongue used for sensing. Flexible jaws and teeth used for biting and tearing. Internal lungs with large surface areas. Excretory system designed to save water and return in to tissues. Reptiles are ectotherms. Need for internal fertilization:
- Males have special structures to introduce sperm into the female's body.
- Sperm is then protected from the environment allowing for more successful fertilization.
- Reptiles do not need to lay as many eggs.
- Eggs laid on land which requires them to have special characteristics:
  - Amniotic egg provides protection and nourishment to the embryo
  - Yolk, amnion, allantois, chorion

### Diversity of reptiles (26.2)
- Tuataras
- Turtles and tortoises
- Snakes and lizards
- Crocodilians

### Characteristics of Birds (26.4)
- Structural adaptations for flight makes birds' bodies lighter and more compact. Shape of wings: slightly curved from front to back, and thicker in front than in back. Thin skin covered with feathers, scales found on legs and feet.

  Feathers are modified reptilian scales: larger and fringed on edges, made of keratin. Used for insulation and provide a low-friction surface. Are lost once or twice a year.
  - Two types of feathers: Contour feathers and down feathers.
    - Contour feathers: Stiff central shaft with interlocking barbs.
    - Down feathers: Short shafts with fluffy bards. Used for insulation.
  - Skeleton: hollow bones that are light and strong due to cross braces within the spaces. Some bones are fused which provided more rigidity for flight and reduces the need for heavy ligaments.

- Energy and Wastes
  - Birds are endotherms (warm-blooded). Allows them to live in all climates. Feathers act as insulation and help keep water out.
  - Birds have more efficient respiratory, digestive, and circulatory systems than reptiles.
  - Birds have a fast heart rate and four-chambered heart to separate the low and high oxygen blood.
  - Birds’ lungs are attached to several air sacs that extend throughout the whole body attached to lungs. Air only travels through lungs in one direction.
  - Digestive structures: beak, esophagus, crop, gizzard, intestine.
  - Excretory system designed to conserve water. Urine passed as a pasty form.
  - Birds have no urinary bladder to store liquid waste, as a way to reduce mass for better flight.
  - Beaks used to obtain and tear food, feet used to grasp and kill prey.

- Bird life cycle: Reproductive systems adapted to allow for flight
  - Males have small testes, females have only one ovary.
  - Internal fertilization occurs through the cloaca.
Birds lay amniotic eggs like reptiles but structures are different than in reptile eggs. Eggs must be incubated for development to continue successfully.

- Evolutionary origin of birds
  Birds probably evolved about 225 million years ago.
  Fossils show evolutionary links between reptiles and birds—Archaeopteryx
  Birds most likely evolved following the extinction of dinosaurs.
  Feathers originally evolved to maintain warmth allowed for flight and allowed birds to move quickly around the world and into new habitats.

Mammals (Chapter 27)

- Characteristics of Mammals (27.1)
  Class Mammalia: endothermic vertebrates with hair.
  Females have mammary glands that produce milk for their young.
  Skeletons adapted for different types of movement.
  Mammals have the largest and most developed brains in the animal kingdom.
  Various teeth for various food sources.
  Length of digestive tract reflects their diets.
  Respiratory system adaptations: diaphragm and air sacs in lungs.
  Double-loop circulatory system with a four-chambered heart.
  Kidneys control water and waste balance.
  Life cycles of Mammals:
    Monotremes: mammals that lay eggs.
    Platypus, echidnas, anteaters
    Marsupials: give birth to small under-developed young and finish developing inside their mother's pouch.
    Opossums, kangaroos, koalas
  Placental: young develop and are nourished within the mother until birth.
    Rodentia
    Lagomorphia (hares, pikas, rabbits)
    Chiroptera (Bats)
    Carnivora
    Cetacea (dolphins, porpoises, whales)
    Sirenia (manatees, dugongs)
    Insectivora (moles, shrews, hedgehogs)
    Ungulates:
      Artiodactyla: even number of toes (pegs, camels, deer)
      Perissodactyla: odd number of toes (horses, zebra, rhinoceroses)
      Proboscidea (elephants)
      Primates (humans, apes, monkeys)

- Origin and diversity of Mammals (27.2)
  Evolved from mammal-like reptiles. Became nocturnal since they were endothermic and did not require the sun to regulate body temperature. Required much more food and space compared to reptiles to stay alive and maintain temperature.
  Milestones: development of hair, internal embryo development, developing placenta.

- Ecological roles of mammals (27.3)
  Feed at various levels of the food chain.
  Seed dispersal
  Can alter environments in which they live: can be helpful or harmful.
Can carry diseases to humans and other animals.
Used as food source.
Help humans do various work: farm tasks, transportation, assistance of people (retrieving seeing eye dogs), behavioral or medical research.

**ZOOLOGY**
**AN INTRODUCTORY COURSE:**

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**BIOLOGY II (Botany/Zoology) Outline**

Classification (Chapter 13)
- Grouping Organisms, kingdoms, naming organisms (13.1)
- Phylogenetic trees (13.2)
- Dichotomous keys (13.3) → Shark key lab

*Origin and Diversity of Plants (Chapter 20)*
- Natural history of plants (20.1)
  - Ancestors of green algae
  - Divisions of plants
    - Non-vascular plants: mosses, liverworts, hornworts
    - Vascular plants: seedless and seeded plants
  - All have roots, stems and leaves: ferns, gymnosperms, angiosperms

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- **Mosses (20.2)**
  Characteristics of mosses
  - Non-vascular: no roots or leaves (have rhizoids)
  - Habitat: need water for reproduction
  Moss life cycle
  - Gametophyte: produces egg and sperm
    - Male: antheridium
    - Female: Archegonium
  - Capsules: production of spores
  Role of mosses: decomposers, prevent water and soil loss, shelter, nesting materials, fuels

- **Ferns (20.3)**
  Characteristics of ferns:
  - Largest group of seedless plants
  - Habitat: requires most area for reproduction
  - Vascular: have true leaves/stems/roots
  Fern life cycle:
  - Sporophyte stage: typical with roots/stems/leaves
  - Have sorus: underside of leaves that produce spores
  - Sporophytes produce gametophytes: similar to mosses
  Role of ferns:
  - Ecological succession, food, nitrogen fixation, horticulture

- **Conifers (20.4)**
  Characteristics of Conifers:
  - Vascular plants
  - Bear cones
  - Needle-like leaves (evergreens): less transpiration
  - Gymnosperms: produce seeds in cones, male and female
  - Cones, “naked seeds” (not enclosed in fruit)
  Conifer life cycle:
  - Both sporophyte and gametophyte stages
### Pacing Guide

Below is a list of topics and a suggested number of 88-minute class periods to cover the content and the knowledge and skills objectives.

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<td>4</td>
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<tr>
<td>Reptiles/Structure of the Amniotic Egg</td>
<td>4</td>
</tr>
<tr>
<td>Characteristics and Diversity of Birds</td>
<td>Optional if time allows</td>
</tr>
<tr>
<td>Characteristics and Diversity of Mammals</td>
<td>8</td>
</tr>
</tbody>
</table>
Overview:
Field Ecology and Animal Behavior is a lab-based course that explores the relationships between organisms and the non-living environment. The course is designed for serious science students who are self-motivated and have an interest in biological or environmental science. This course teaches not only the content of ecology and animal behavior, but also the lab methods and techniques required to obtain accurate and valid data from experiments. Topics of study include, but are not limited to: the elements of an ecosystem, comparisons of different ecosystems and biomes, transect line and quadrant sampling, plant specimen preservation and identification, populations, toxicology and risk assessment, and innate and learned animal behaviors. This course offers open-ended laboratory activities, and students will be required to design, run, and collect data from their own experiments. Strong analysis, writing, and graphing skills are a must. Students are assessed by a variety of methods including the writing of research papers and lab reports, presentations, homework, and tests. Students who are squeamish when handling live animals or who do not enjoy fieldwork are strongly advised not to take this course. Students must be prepared to do field work regardless of weather.
Content: Curriculum for Field Ecology and Animal Behavior

Course Philosophy
FEAB will be taught to help all students develop good questioning skills to become critical & scientific thinkers in a safe and caring environment in alignment with the New Jersey Core Content Standards for science.

NJ Content Standards
The following standards have been covered within this curriculum:

5.1
5.1. Strand A
Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.
Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.

5.1 Strand B
Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
Mathematical tools and technology are used to gather, analyze, and communicate results.
Empirical evidence is used to construct and defend arguments.
Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.

Strand C
Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
Data and refined models are used to revise predictions and explanations.
Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.

Strand D
Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.
Science involves using language, both oral and written, as a tool for making thinking public.
Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically.

5.1.B- Inquiry and Problem Solving
5.2.A- Cultural Contributions
5.2.B – Historical Perspectives
5.3.D- Data Analysis and Probability
5.5.A- Matter, Energy and Organization in Living Systems
5.5.B- Diversity and Biological Evolution
5.5.C- Reproduction
5.6.B- Chemical reactions
5.8.A- Earth’s Properties and Materials
5.10.A- Natural Systems and Interactions
5.10.B- Human Interactions and Impact
Enduring Understandings:

- The modern views and understanding of the environment has been shaped by the attitudes and religious beliefs of several ancient civilizations.
- Ecosystems are controlled and influenced by several biotic and abiotic factors.
- Biomes are influenced by several factors such as: location on the planet, climate, annual precipitation, types of vegetation, types of animals, and other unique characteristics.
- Performing scientific experimentation is an actively creative process that requires well-planned experiments that control variables and allow for accurate data collection.
- Succession is the process by which mature ecosystems form on barren ground where no organisms previously existed.
- Biodiversity provides many organisms that are able to fill multiple roles or niches, provides health to the ecosystem by providing variations that allow for new adaptations to develop, and reduces the risk of species being affected by disease, climate change, invasive species, immigration, and emigration.
- The soil ecosystem is made up of several different micro and macro organisms that all have very specific roles to ensure water and nutrients are uniformly distributed.
- Population size is affected by several influences including biotic and abiotic factors, natality, mortality, immigration and emigration.
- The basic principles of toxicology can be used to help understand how chemicals in the environment, both natural and man-made, affect organisms and how those chemicals are able to destroy resources and ecosystems.
- Animals behave in differently depending upon many factors caused by the environment, different stimuli, or the different needs of animals in different situations.
- In order for animals to survive and reproduce, they must develop behaviors that will increase their likelihood of survival under many different conditions.
- Many animals are capable of learning advantageous behaviors through conditioning, trial and error, or logical problem solving strategies.
- Certain behaviors have evolved to allow animals to pass advantageous characteristics to their offspring, giving future generations a better chance to survive.

Essential Questions:

- How have the modern views and understanding of the environment been shaped by the attitudes and religious beliefs of several ancient civilizations?
- How are ecosystems controlled and influenced by biotic and abiotic factors?
- How are biomes influenced by factors such as: location on the planet, climate, annual precipitation, types of vegetation, types of animals, and other unique characteristics?
- Why is performing scientific experimentation an actively creative process that requires well-planned experiments that control variables and allow for accurate data collection?
- How is succession the process by which mature ecosystems form on barren ground where no organisms previously existed?
- How does biodiversity provide health to ecosystems?
- What are the roles of micro and macro organisms in the soil that ensure water and nutrients are uniformly distributed?
- What are the factors and rates that influence population size?
- What are the basic principles of toxicology and how can they be used to help understand how chemicals in the environment affect organisms?
- Why do animals behave differently depending upon many factors caused by the environment, different stimuli, or the different needs of animals in different situations?
- What types of behaviors are needed by animals in order to survive and reproduce?
- How are animals capable of learning advantageous behaviors?
How have certain behaviors evolved to allow animals to pass advantageous characteristics to their offspring, giving future generations a better chance to survive?

Knowledge and Skills:
Students will know and be able to-

- Write a well-structured essay explaining how the modern attitudes towards the environment have been influenced by several ancient societies.
- Define the terms Ecology and Ecosystem.
- Describe biotic and abiotic factors within ecosystems.
- Define the terms mortality, natality, immigration, and emigration.
- Show the interactions between biotic and abiotic factors within an ecosystem.
- Define the term Biome.
- Deduce factors that control the position of biomes on the planet.
- Design a well-controlled experiment to test a single variable and to collect accurate data.
- Define the term succession.
- Describe the differences between primary, secondary and deflected succession.
- Predict how ecosystems will change as different abiotic factors change as well.
- Record observations describing the types of succession found on the school campus and create a diagram showing where the different types of succession can be found.
- Define the term biodiversity and describe the importance of biodiversity in stable ecosystems.
- Use quadrant analysis and the Transect Line method to measure biodiversity in several areas of the high school campus.
- Identify the component parts of the soil community ecosystem.
- Describe the ecological roles of several different organisms in the soil ecosystem.
- Perform a soil analysis on several soil samples collected from the high school campus.
- Define the term population
- Review the importance of biotic and abiotic factors, natality, mortality, immigration and emigration on population size.
- Define the terms limiting factor, carrying capacity and doubling time.
- Evaluate a data set for two populations and determine which of the population control factors are most influential in a given environment.
- Create a simulation that shows how biotic and abiotic factors, natality, mortality, immigration and emigration affect the growth of an eagle population.
- Describe how humans are affecting their own population by using and distributing valuable resources.
- Grow several yeast cultures using different solutions as food sources and determine which conditions are most successful for the population to grow.
- Define the term disease, and distinguish between infectious, non-infectious, contagious and non-contagious diseases.
- Use basic principles of epidemiology to determine how an infectious, contagious disease can rapidly spread within a population.
- Analyze data about the spread of HIV and determine why certain populations are more susceptible to diseases than others.
- Use the mark-and-recapture method to estimate the size of a population of mobile animals.
- Simulate real-life situations where questions about the appropriate use of land must be determined and different land use proposals must be evaluated in a fictitious case.
- Describe the effects invasive species can have on an environment.
- Research one particular invasive species and describe how that species has caused economic or
environmental harm, or harm to human health.

- Define the term Toxicology and describe how toxicology can be used to determine how chemicals adversely affect living organisms.
- Describe the differences between immediate and delayed toxicity.
- Describe the three ways toxicants work to cause adverse effects in organisms and the biological factors that influence toxicity.
- Define the terms bioaccumulation and biological magnification.
- Describe how exposure to toxicants can cause genetic mutations, cancer and birth defects.
- Observe how different household chemicals and substances can affect the growth of radish plants and research the mechanisms used by those substances to alter the plant’s growth.
- Participate in a role-playing activity to simulate writing national laws to limit the release of toxic chemicals into the environment, and to hold a mock senate hearing to debate the pros and cons of legislating environmental policies.
- Describe the differences between kinesis and taxis behaviors, and be able to describe the stimulus that causes such behaviors.
- Observe how classic conditioning can be used to learn and unlearn new behaviors.
- Conduct an experiment that will show earthworms’ unlearned response to light and to gravity.
- Design and implement an experiment to test crickets’ ability to learn to respond in novel ways to different situations.
- Describe how the principles of Natural Selection can be used to allow successful adaptations and behaviors to be passed on to future generations of organisms.
- Summarize the important components of breeding behaviors and describe several examples of courtships, sign stimulus, and territoriality behaviors.
- Describe how animals use posture, vocalizations, expressions and body language to show intent, aggression, dominance, and submission.
- Describe the factors that determine successful feeding strategies for animals.
- Determine the survival advantages to animals that migrate and describe the reasons why certain animals follow certain migration routes.
- Write a persuasive essay to support beliefs about whether animals are able to learn in a way that shows true understanding, if animals are able to feel true emotions, and if animals have self-awareness.

Labs/Activities:

- Reflection Essay: “Ancient Roots of our Ecological Crisis” article
- Weekly Current Event: FEAB in the News
- Borneo Simulation
- Biome research posters
- Lab: The “Jelly-Side Down” Lab
- BSCS Investigation 22.3- Long-term changes in an ecosystem
- Field observations of succession/ creation of a campus succession map
- Lab: Performing a Quadrant Analysis of several adjacent areas of the high school campus.
- Lab: Using a Transect Line to measure biodiversity in an area of the high school campus.
- Ecological roles of soil organism research activity.
- Lab: Soil Analysis
- BSCS Investigation 2.2- Population Growth
- Eagle Population Simulation
- Video and Discussion- The Day of Six Billion
- Lab: Observing Population Growth in Simple Organisms
- Lab: Transmission of Diseases
Evidence of Learning:

- Creation of a flowchart/diagram that shows how biotic and abiotic factors influence ecosystems.
- Research the aspects of various biomes and create a poster that highlights the major characteristics of each.
- Plan, design, and run an experiment to see what conditions cause toast to always land jelly-side down. Students will write a full lab report that explains all hypotheses, materials, procedures, collected data, analysis, and conclusions.
- Create a food web based on information provided about an ecosystem, predict changes that will occur due to changes in abiotic factors, and create a new food web to illustrate the new ecosystem.
- Create a map of the campus that shows where different types of succession can be found.
- Creation of a diversity table used to describe the distribution of species following a quadrant analysis of several adjacent areas of the high school campus.
- Write a formal lab report describing the biodiversity and soil characteristics of a section of the high school campus.
- Completion of the Ecological Roles of Soil Organisms chart.
- Completion of the Soil Analysis data sheet along with the descriptions and sketches of the organisms found in the soil samples.
- Completion of BSCS Investigation 2.2.
- Completion the Eagle population simulation activity.
- Discussion questions and group discussion following the Day of Six Billion video.
- Prepare a data tables and a graph that describes how yeast culture populations grow under different conditions and write a conclusion summarizing the data.
- Generation of a “conversation tree” that describes how an infectious and contagious disease can spread within population.
- Student responses to Epidemiology of AIDS: Global Data Analysis and Discussion Questions.
- Reflection essay of the film And the Band Played On
- Completion of the Biology the Web of Life: Lab 61- Estimating Mobile Population Sizes lab packet and analysis questions.
- Role-play scenario for BSCS Investigation 24.2: Decisions About Land Use- research on various
assigned roles, generation of a land use map, and completion of analysis questions.

- Research and present information to the class about one particular invasive species and describe how that species has caused economic or environmental harm, or harm to human health.
- Outline of Environmental Science Chapter 19: Principles of Toxicology and Risk Assessment.
- Lab Report: Exposing Radish Plants to Toxic Substances
- Research various roles for Role Play Simulation: Amending the Clean Air Act, developing pro and con arguments for amending the law, research on various states involved in the debate, writing of a lobbying statement or voting statement.
- Collection and analysis of data during classic conditioning experiments to determine how a stimulus can be used to influence simple behaviors.
- Collect and evaluate data and draw conclusions about how earthworms respond to the stimuli of light and gravity.
- Lab report for Designing an Experiment to Evaluate the Response of Crickets to Various Stimuli.
- Collection and analysis of data to determine which wing designs are best suited for flight in the Evolution of Flight Behavior simulation.
- Comparison of the ability to successfully communicate using either only verbal or only visual methods during the Visual Communications simulation.
- Optimal Foraging worksheet and analysis questions.
- Collection of bird migration distance data during the “Flight for the Border” bird migration game.
- Completion of a persuasive writing essay supporting beliefs about whether animals are able to learn in a way the shows true understanding, if animals are able to feel true emotions, and if animals have self-awareness.

Cross Curricular:
1. Students will be required to build on the knowledge already acquired in prerequisite courses of Biology and Chemistry.
2. During this course students are required to perform mathematical analysis on data to develop valid and supported conclusions during scientific experiments.
3. Students are required to evaluate and analyze many situations that give them a historical perspective on ecological issues.
4. Students will be exposed to how the cultures of different countries handle issues such as population growth, environmental pollution, conservation of resources, and the protection of endangered species.

Character Education:
Students will be required to complete all tasks and assignments in accordance with the Academic Integrity policies of South Brunswick High School.

Career:
Standard 9.1 (Career and Technical Education) All students will develop career awareness and planning, employability skills, and foundational knowledge necessary for success in the workplace.

B. Employability Skills:
- Select and utilize appropriate technology in the design and implementation of teacher-approved projects relevant to occupations and/or higher educational settings.
- Demonstrate teamwork and leadership skills that include student participation in real world applications of career and technical education skills.

Standard 9.2 (Consumer, family, and life skills) All students will demonstrate critical life skills in order to be functional members of society.
A. Critical Thinking
Apply communications and data analysis to the problem solving and decision making processes in a variety of life situations.
Apply the use of symbols, pictures, graphs, objects, and other visual information to a selected project in academic and/or occupational settings.
Recognize bias, vested interest, stereotyping, and the manipulation and misuse of information while formulating solutions to problems that interfere with attaining goals.

F. Safety
Engage in an informed discussion about rules and laws designed to promote safety and health.
Practice the safe use and tools and equipment.
Implement safety procedures in the classroom and workplace, where appropriate.

Technology:

**Strand F:** Critical Thinking, Problem Solving and Decision Making
8.1.12.F.1: Select and use specialized databases for advanced research to solve real world problems.

**Course Outline:**
The following topics will be covered while meeting the educational and behavioral objectives described above.

**Definitions of Ecology and Ecosystems**
The study of the interactions between the living organisms and the non-living components of the planet
Role of Biotic Factors:
- Plants, animals, pathogens, organisms used as food, diseases, competition, predation
- Ecological Rates:
  - Natality, mortality, immigration, emigration

Role of Abiotic Factors:
- Climate, water, space

Role of Diversity and Different Terrestrial Biomes
Definitions of biological diversity and biomes
- The relationship between biological diversity and the stability of ecosystems and biomes
- Locations of biomes on the planet and the similarities in locations and climates

Types of Succession
- Primary succession: characteristics of pioneer, intermediate and climax communities
- Roles and examples of ecological disturbances in influencing succession
- Secondary succession: differences between secondary and primary succession
- Deflected succession: result of repeated human action
- Measuring succession using a transect line analysis

Importance of Biodiversity and Ecosystem Stability
Review definitions of biodiversity, importance of niches: roles organisms play in ecosystems
Measuring biodiversity by using a quadrant analysis

Components of Soil Ecosystems
Roles of bacteria, protozoa, fungi, arthropods, nematodes and earthworms in maintaining soil ecosystem health.
Data collection on water capacity, soil type, and micro and macro organisms found in various soil samples.

**Populations**
- Definitions of population and population ecology
- Review of ecological rates/biotic and abiotic factors
- Calculation of doubling time as a method to determine the rate of population growth
- Definition of carrying capacity and factors that influence it
- Use of the “tag and re-capture” method for determining the size of mobile populations
- Description of the issues involved in using land for various human needs

**Role of Disease in Controlling Population Size**
- Definition of disease
- Description of infectious diseases: contagious and non-contagious infectious diseases
- Description of non-infectious diseases
- Comparisons of viruses and other types of pathogens
- The effects of HIV/AIDS on the human population
- Methods used to track and contain infectious/contagious diseases within populations: epidemiology, quarantining, and immunizations

**Principles of Toxicology**
- Definition of toxicants
- Routes of exposure
- Immediate vs. delayed toxicity
- Local and systemic toxic effects
- Three ways toxicant cause adverse effects
- Factors that influence toxicity
- Bioaccumulation and biological magnification

**Mutations, Cancer and Birth Defects**
- Definition of mutagen
- The effect of somatic and germ cell mutations
- Definition of cancer and the malignant and benign tumors
- DNA-reactive, genotoxic and epigenetic carcinogens
- Birth defects and teratogens

**Innate Animal Behaviors**
- Definition of behavior
- Types of innate behaviors: reflex behaviors, kinesis, taxis, stereotyped behaviors
- Fixed action patterns and releasers

**Learned Animal Behaviors**
- Definition of stimulus
- Imprinting, conditioning, substitute stimulus

**Breeding Behaviors**
- Courtship behaviors and territoriality
- Advantages to using courtship and competition for mate selection
- Visual communication and rituals
Feeding Strategies and Migration Behaviors

Development of strategies to obtain food: trial and error, observation behaviors
Definition of migrations: reasons for migrations, advantages and disadvantages, cost and benefits
Pacing Guide:
Below is a list of the topics of the course outline and a suggested number of 88-minute class periods to cover the content and the knowledge and skills objectives.

<table>
<thead>
<tr>
<th>Course Outline Topics/Content</th>
<th>Suggested Number of Class Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitions of Ecology and Ecosystems</td>
<td>4</td>
</tr>
<tr>
<td>Role of Diversity and Different terrestrial Biomes</td>
<td>5</td>
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<tr>
<td>Types of Succession</td>
<td>10</td>
</tr>
<tr>
<td>Biodiversity and Ecosystem Stability</td>
<td>5</td>
</tr>
<tr>
<td>Components of Soil Ecosystems</td>
<td>5</td>
</tr>
<tr>
<td>Populations</td>
<td>15</td>
</tr>
<tr>
<td>Role of Disease in Controlling Population Size</td>
<td>9</td>
</tr>
<tr>
<td>Principles of Toxicology</td>
<td>12</td>
</tr>
<tr>
<td>Mutations, Cancer and Birth Defects</td>
<td>5</td>
</tr>
<tr>
<td>Innate Animal Behaviors</td>
<td>5</td>
</tr>
<tr>
<td>Learned Animal Behaviors</td>
<td>5</td>
</tr>
<tr>
<td>Breeding Behaviors</td>
<td>5</td>
</tr>
<tr>
<td>Feeding Strategies and Migration Behaviors</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total = 90</strong></td>
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</tbody>
</table>
Overview:

Human Anatomy and Physiology is an Honors course focused on the study of the structures and functions of the human body. The course is organized according to levels of increasing complexity from the cellular level on up to the organ systems and their interaction and coordination. Some of the many topics covered will be the terminology and relationships of body parts, the regulating mechanisms (hormones and nervous system) within the body, the responses to stress and the pathological disorders (diseases) of the human body. Other organisms will be utilized in order to compare and contrast anatomies. A large portion of the course will revolve around a variety of laboratory activities. The laboratories will include: microscope use, chemical analysis, use of anatomical models, guided dissection, open ended experimentation, and the use of various technologies such as computer simulations, interfacing, CD ROMS and Video Disks. The course is designed for students who will be pursuing one of the many careers in the health sciences (this includes technologists as well as emergency care workers) or students who are interested in expanding their present knowledge of the human body. The student’s grade in this course will be based on laboratory work and reports, tests, projects, homework, and lab practicals. Due to the nature of the course itself, there is a considerable amount of memorization and mastery of advanced vocabulary necessary for its successful completion.
Course Title: Human Anatomy and Physiology (Honors)

Content:
Human Anatomy & physiology is an honors level course focused on the study of the structures and functions of the human body. This class will be taught at quite a high level (by its very nature the recall of vocabulary and terminology is necessary). Success in this course will depend on a student’s willingness to put forth a continuous effort. The type of studying necessary for the course might be new to students.

An integral part of the course will revolve around a variety of laboratory activities. The laboratories will include: microscope use, chemical analysis, use of anatomical models, guided dissection, open minded experimentation, and the use of various technologies.

Philosophy:
HA & P will be taught in a manner to help all students develop good questioning skills to become critical & scientific thinkers and questioners of facts and information, rather than mere consumers of knowledge, in a safe and caring environment using the HA & P concepts in a manner consistent with the New Jersey Core Content Standards for Biology.

There are many devices used in this course to help the student retain and apply the complicated subject matter. One of the vehicles is the use of preserved animals and their dissection. It is essential that no life be trivialized and that the students gain the maximum information from these experiences. If in the judgment of the teacher, a student is not taking their obligation to respect the former lives of these specimens seriously, the student will be given a zero in the present lab and on all future labs involving dissection. A conference will be held with the student, their parents, the Science Supervisor and the teacher in which the student's continuing enrollment in the course will be evaluated.


<table>
<thead>
<tr>
<th>Desired Results</th>
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<tbody>
<tr>
<td>NJ Content Standards</td>
</tr>
<tr>
<td>Currently no state standards exist for this course; however, it builds on and extends previously mastered Biology I standards.</td>
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<table>
<thead>
<tr>
<th>Enduring Understanding(s)</th>
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<tbody>
<tr>
<td>Essential Question(s)</td>
</tr>
<tr>
<td>Knowledge &amp; Skills (student outcomes)</td>
</tr>
</tbody>
</table>

I. ENDURING UNDERSTANDING:
The human body has many structural and functional levels.

Essential Questions:
What molecules are essential to living things?
How are cells organized to make tissues?
How are tissues organized to make organs?
How are organs organized to make systems?
Is homeostasis the most important concept with regards to the human body?
II. ENDURING UNDERSTANDINGS:
Medical terminology is essential when describing anatomic structure and physiology. These terms are universally known.

There is a comprehensive language that applies to the structure of animals that is based in Latin and Greek.

Essential Questions:
What common terminology is used to describe human anatomy?

Student Outcomes:
A. Students will understand body terminology.
   1. Successfully describe human body parts, planes, and areas using appropriate terminology

III. ENDURING UNDERSTANDINGS:
Matter can be described, organized, and classified for understanding.

Chemical changes affect structure and function of living things.

Essential Questions:
What is the chemical composition of the Human Body?

Student Outcomes: The students will:
A. Relate atoms, ions, and molecular structure to cell chemistry and function.
B. Compare and contrast the structure and function of proteins, carbohydrates, lipids and nucleic acids.
D. Apply acids, bases and electrolytes to living things.
E. Relate pH scale to acids and bases and common chemical materials and the human body.

Activities/Topics
Students will learn about the following:
- Introduction to HAP
- Chemical Basis of Life
- Cells
- Tissues
- Skin
- Muscular
- Skeletal
- Nervous
- Somatic and Special Senses
- Endocrine
- Digestive
- Respiratory
- Blood
- Cardiovascular
- Lymphatic and Immune
- Urinary
- Reproduction
- Pregnancy, Growth and Development
See course outline for scope and sequencing.

<table>
<thead>
<tr>
<th>Assessment</th>
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<tbody>
<tr>
<td>Evidence of Learning</td>
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<tr>
<td>1. Laboratory reports (based on labs and dissections)</td>
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<tr>
<td>2. Tests</td>
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<tr>
<td>3. Homework</td>
</tr>
<tr>
<td>4. Lab practicals and clinical simulations (problem solving scenarios)</td>
</tr>
<tr>
<td>5. Student self-assessment of student progress, co-operation and academics</td>
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<tr>
<td>6. Teacher assessment of student progress, co-operation and academics</td>
</tr>
<tr>
<td>7. Projects and/or written reports</td>
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<table>
<thead>
<tr>
<th>21 Century Connections</th>
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<tbody>
<tr>
<td>Cross Curricular –</td>
</tr>
<tr>
<td>All are reinforced constantly throughout the year. Delivered throughout the course in the form of teacher led Labs, Student Labs, Student projects, Lab Practicals, Lab Reports.</td>
</tr>
<tr>
<td>Physics- Levers, Motion, Biomechanics</td>
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<tr>
<td>Mathematics- Size measurements and conversions with a microscope</td>
</tr>
<tr>
<td>History- Perspectives of Medical discoveries in a Historical Overview- Video shown- “Guns, Germs and Steel”</td>
</tr>
<tr>
<td>Technology- 3D Modeling, Student generated PowerPoint’s, TED Lectures</td>
</tr>
<tr>
<td>Psychology- Nervous System, Senses, Brain</td>
</tr>
<tr>
<td>Chemistry- pH, Osmosis, Diffusion, Relationships between structure and function</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Character Education-</th>
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<tbody>
<tr>
<td>All are reinforced constantly throughout the year. Delivered throughout the course in the form of teacher led Labs, Student Labs, Student projects, Lab Practicals, Lab Reports.</td>
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<tr>
<td>Kindness</td>
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<td>Respect</td>
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<td>Responsibility</td>
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<tr>
<td>Honesty</td>
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<td>Service</td>
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<tr>
<th>Career</th>
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<tbody>
<tr>
<td>All are reinforced constantly throughout the year. Delivered throughout the course in the form of teacher led Labs, Student Labs, Student projects, Lab Practicals, Lab Reports.</td>
</tr>
<tr>
<td>Overview of the Allied Health Profession with application to each topic studied.</td>
</tr>
</tbody>
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<thead>
<tr>
<th>Technology</th>
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<tbody>
<tr>
<td>Microscope use, teacher and student generated Powerpoints, Projector, Computers.</td>
</tr>
</tbody>
</table>
# Course Outline and Pacing guide:

<table>
<thead>
<tr>
<th>TIME</th>
<th>TOPIC</th>
<th>CHAPTER</th>
<th>LABS (with lab number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter 1</td>
<td>Introduction to HAP</td>
<td>1</td>
<td>1. Body Organization and Terminology</td>
</tr>
<tr>
<td></td>
<td>Chemical Basis of Life</td>
<td>2</td>
<td>2. Care and Use of the Microscope</td>
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<tr>
<td></td>
<td>Cells</td>
<td>3</td>
<td>3. Cellular Structure</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>4. Movements through a Cell Membrane</td>
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<td>5. Life Cycle of a Cell</td>
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<td>Tissues</td>
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<td>6. Epithelial Tissues</td>
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<td>7. Connective Tissues</td>
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<td>8. Muscle and Nervous Tissues</td>
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<td>Skin</td>
<td>6</td>
<td>9. Integumentary System</td>
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<td>Lab Practical / Self-Evaluation and Assessment</td>
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<tr>
<td>Quarter 2</td>
<td>Muscular</td>
<td>7</td>
<td>Dissection Introduction</td>
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<td>17. Skeletal Muscle Structure</td>
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<td>20. Muscles of the face and Neck</td>
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<td>21. Muscles of the Chest and Shoulders</td>
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<td>22. Muscles of Back, Abdomen, pelvis</td>
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<td>23. Muscles of Hip and Lower Limbs</td>
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<td>24. Cat Dissection (Musculature)</td>
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<td>Skeletal</td>
<td>8</td>
<td>16. The Joints</td>
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<td>10. Structure and Classification of Bone</td>
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<td>11. Organization of the Skeleton</td>
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<td>12. The Skull</td>
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<td>13. Vertebral Column and Thoracic Cage</td>
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<td>14. Pectoral Girdle and Lower Limb</td>
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<td>15. Pelvic Girdle and lower Limb</td>
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<td></td>
<td>Nervous</td>
<td>9</td>
<td>25. Nervous tissue</td>
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<td>27. The Reflex Arc and Reflexes</td>
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<td>28. The Meninges and Spinal Cord</td>
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<td>29. The Brain and Cranial Nerves</td>
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<td>30. Dissection of the Brain</td>
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<td>Somatic and Special Senses</td>
<td>10</td>
<td>31. Receptors and Somatic Senses</td>
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<td>32. Senses of Smell and Taste</td>
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<td>33. The Ear and Hearing</td>
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<td>34. The Sense of Equilibrium</td>
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<td>35. The Eye</td>
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<td>36. Visual Tests</td>
</tr>
</tbody>
</table>

237
<table>
<thead>
<tr>
<th>TIME</th>
<th>TOPIC</th>
<th>CHAPTER</th>
<th>LABS (with lab number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Practical / Self-Evaluation and Assessment</td>
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<tr>
<td>Quarter 3</td>
<td>Endocrine</td>
<td>11</td>
<td>37. Endocrine System</td>
</tr>
</tbody>
</table>
|               | Digestive          | 12      | 49. Organs of the Digestive System  
                          |                                                | 50. Cat Dissection: Digestive System  
                          |                                                | 51. Action of the Digestive System          |
|               | Respiratory        | 13      | 52. Organs of the Respiratory System  
                          |                                                | 53. Cat Dissection: Respiratory System  
                          |                                                | 54. Breathing Volumes and Capacities  
                          |                                                | 55. Control of Breathing                   |
|               | Blood              | 14      | 38. Blood Cells  
                          |                                                | 39. Blood testing (Demonstration)  
                          |                                                | 40. Blood Typing                          |
| Lab Practical / Self-Evaluation and Assessment |                    |         |                                                                                       |
| Quarter 4     | Cardiovascular     | 15      | 41. Structure of the Heart  
                          |                                                | 42. Cardiac Cycle  
                          |                                                | 44. Blood Vessels  
                          |                                                | 45. Pulse Rate and Blood Volume  
                          |                                                | 46. Major Arteries and Veins  
                          |                                                | 47. Cat Dissection: Cardiovascular        |
|               | Lymphatic and Immune| 16      | 48. Lymphatic System                                                                    |
|               | Urinary            | 17, 18  | 56. Structure of the Kidney  
                          |                                                | 57. Urinalysis  
                          |                                                | 58. Cat Dissection: Urinary System         |
|               | Reproduction       | 19      | 59. Male Reproductive System  
                          |                                                | 60. Female Reproductive System  
                          |                                                | 61. Cat Dissection: Reproduction           |
|               | Pregnancy, Growth and Development | 20 | Lab Practical / Self-Evaluation and Assessment                                         |
Laboratory Schedule: Human Anatomy & Physiology

The nature of the laboratories in Human Anatomy & physiology are observational. They do not lend themselves to complete lab report formats. We assign the lab reports that accompany the laboratory text in the course. We accomplish higher level thinking skills by administering rigorous laboratory practicals following each topic cluster. The time spent in each laboratory topic varies considerably within the topics.

Laboratory Human Anatomy and Physiology (Web references)
Laboratory Exercise 1
Examine additional information about the scientific method.
http://teacher.nsrl.rochester.edu/phy_labs/Appen
dixE/AppendixE.html

Laboratory Exercise 2
Identify organs in the three planes of the body from digitized sections of a human body.
http://www.madsci.org-lynn/VH/

Laboratory Exercise 3
Explore additional explanations on proper microscope use.
http://www.ruf.rice.edu/~bioslabs/methods/micro
oscopy.microscopy.html

Laboratory Exercise 4
Review cell structure and function
http://www.gen.umn.edu/faculty_staff/jensen/1135/webanatomy/wa_cell_chem

Laboratory Exercise 6
Review the phases of the cell cycle and the events during each phase.

Laboratory Exercise 7, 8, and 9
Identify tissues from micrographs and examine the structural components of tissues.
http://www.meddean.luc.edu/lumen/MedEd.Histo
o/frames/histo_frames.html

Laboratory Exercise 10
Identify skin layers from micrographs and review the functions of the skin layers.
http://www.meddean.luc.edu/lumen/MedEd/medicine/derma
tology/skinlsn/skin.htm

Laboratory Exercise 13, 14, 15, and 16
What are the functions of individual bones and features?
http://www.innerbody.com/htm/body.html

Laboratory Exercise 17
Why does the shoulder joint allow extensive movement? What is joint fluoroscopy?
http://www.vh.org/Providers/Textbooks/JointFlu
oro/Text/shoulder.html

Laboratory Exercise 20, 21, 22, and 23
Determine the origin, insertion, action, nerve, innervation, and blood supply of all the major muscles.
http://www.ptcentral.com/muscles/identifymuscle
es and detailed explanations from an interactive site.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 27 and 29
Describe the development of the nervous system and review the brain, cranial nerves, spinal cord, and CSF.
http://www.bethisraelny.org/inn/anatomy/anato
my.html

Laboratory Exercise 33
What are the causes of hearing impairment?
http://www.hear-it.org/

Laboratory Exercise 35
How do we see?
http://www.gen.umn.edu/faculty_staff/jensen/1135/webanatomy/wa_nervous

Laboratory Exercise 37
What are common endocrine gland disorders? How can they be treated?
http://www.endocrineweb.com
Laboratory Exercise 38
What are the functions of the various blood components? What do abnormal amounts indicate?
http://anthro/palomar.edu/blood/blood_components.htm

Laboratory Exercise 41
Trace blood flow through an animated heart at various rates. Identify heart structures and take an animated tour of the heart.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 42
Identify normal heart sounds and a murmur.
http://www.fi.edu/biosci/preview/hearthear.html
Explore an ECG Learning Center
http://medstat.med.utah.edu/kw/ecg/

Laboratory Exercise 46
Identify the major arteries and veins and describe their functions. Observe the animation of the exchanges in a capillary.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 48
Locate the six major areas of lymph nodes and identify the components of the lymphatic system.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 49
Summarize the functions of the digestive system.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 52
Review the structure and function of the respiratory system.
http://www.gen.umn.edu/faculty_staff/jensen/1135/webanatomy/wa_respiratory

Laboratory Exercise 56
Review the structure and function of the urinary system.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 59
Review the structures and functions of the male reproductive system.
http://www.innerbody.com/htm/body.html

Laboratory Exercise 60
Review the structures and functions of the female reproductive system.
http://www.innerbody.com/htm.body.html

Laboratory Exercise 62
Examine the topics of infertility, fetal developments, pregnancy, birth, and many more.
http://www.babycenter.com
Laboratory Exercise 1: Body Organization and Terminology
Laboratory Exercise 2: Care and Use of the Microscope
Laboratory Exercise 3: Cellular Structure
Laboratory Exercise 4: Movements Through a Cell Membrane
Laboratory Exercise 5: The Cell Cycle
Laboratory Exercise 6: Epithelial Tissues
Laboratory Exercise 7: Connective Tissues
Laboratory Exercise 8: Muscle and Nervous Tissues
Laboratory Exercise 9: Integumentary System
Laboratory Exercise 10: Structure and Classification on Bone
Laboratory Exercise 11: Organization of the Skeleton
Laboratory Exercise 12: The Skull
Laboratory Exercise 13: Vertebral Column and Thoracic Cage
Laboratory Exercise 14: Pectoral Girdle and Upper Limb
Laboratory Exercise 15: Pelvic Girdle and Upper Limb
Laboratory Exercise 16: The Joints
Laboratory Exercise 17: Skeletal Muscle Structure
Laboratory Exercise 18: Skeletal Muscle Contraction
Laboratory Exercise 19: Muscles of the Face and Neck
Laboratory Exercise 20: Muscles of the Chest, Shoulder and Upper Limb
Laboratory Exercise 21: Muscles of the Deep back, Abdominal Wall, and Pelvic Outlet
Laboratory Exercise 22: Muscles of the Hip and Lower Limb
Laboratory Exercise 23-39: Cat Dissection (Musculature-All Systems)
Laboratory Exercise 31-34: Receptors of the Senses
Laboratory Exercise 35: Endocrine System
Laboratory Exercise 36-39: Cardiovascular System
Laboratory Exercise 40: Lymphatic System
Laboratory Exercise 41-42: Digestive System Laboratory Exercise 43: Respiratory System (Breathing Anatomy)
Laboratory Exercise 44-49: Uro-genital System (Male-Female Reproduction)
Science, Technology and Society

Overview:

All SBHS students will develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment in alignment with the New Jersey Core Content Standards for science.

Science is a human endeavor that has a great impact on society. The application of scientific knowledge (technology) has vast social and environmental consequences and must be evaluated in light of these. Society, in turn, influences and provides direction to science and technology. It is important for scientists, politicians, and each citizen to understand the complex interrelationships between science, technology, and society. Students in this course have an opportunity to examine current issues in which science, technology, and society interact, to develop informed responses, and to improve decision-making communication skills. Topics are studied using a thematic, case-study approach. Student evaluation is based on contributions in class, informed participation in discussions, student writing, projects on the major concepts, and the completion of research assignments.
Philosophy and Course Description

According to New Jersey Core Curriculum Content Standards for Science, all students should learn science to assume their role as concerned citizens, equipped with necessary information and decision-making skills. Science and Society will be taught in a manner to help all students develop good questioning skills to become critical & scientific thinkers, in a safe and caring environment using an issue based pedagogy that will employ both cooperative learning and differentiated instructional strategies. The program helps students develop fundamental cognitive skills employed by scientists, nurtures curiosity and teaches them to remain open-minded to individual differences. The topics covered in this course will change depending upon current events and changes in technology.

Fostering the capacity of students to make reasoned and ethical judgments about the impact of science on society, and making them conscious of their individual moral responsibility especially in the context of contemporary issues is the focus of the course. The curriculum in this full-year elective is centered on a list of topics geared to student interest and issues in the news. It is taught for all levels of student achievement and success. It develops an awareness of the world, the science that is involved in our everyday lives, the technological advancements and the impact both of these have on our world as individuals and as a society as a whole.

<table>
<thead>
<tr>
<th>Enduring Understandings</th>
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<tbody>
<tr>
<td>• A critical interdependence exists among science, technology and society.</td>
</tr>
<tr>
<td>• Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.</td>
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<tr>
<td>• Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.</td>
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<tr>
<td>• Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.</td>
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<tr>
<td>• Mathematical tools and technology are used to gather, analyze, and communicate results.</td>
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<tr>
<td>• Empirical evidence is used to construct and defend arguments.</td>
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<tr>
<td>• Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.</td>
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<tr>
<td>• Refinement of understandings, explanations, and models occurs as new evidence is incorporated.</td>
</tr>
<tr>
<td>• Data and refined models are used to revise predictions and explanations.</td>
</tr>
<tr>
<td>• Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.</td>
</tr>
<tr>
<td>• Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.</td>
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<td>• Science involves using language, both oral and written, as a tool for making thinking public.</td>
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<tr>
<td>• Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms.</td>
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<tr>
<td>• Sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents.</td>
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<tr>
<td>• Evolution occurs as a result of a combination of the following factors:</td>
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<tr>
<td>o Ability of a species to reproduce</td>
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<tr>
<td>Essential Questions</td>
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<tr>
<td>Genetic variability of offspring due to mutation and recombination of genes</td>
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<td>Finite supply of the resources required for life</td>
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<td>Natural selection, due to environmental pressure, of those organisms better able to survive and leave offspring</td>
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<tr>
<td>Mass and Energy are conserved quantities.</td>
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<tr>
<td>Energy transfer within and between systems can be described and predicted in terms of energy</td>
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<td>Energy may be transferred from one object to another and from one form to another</td>
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<tr>
<td>Feedback effects exist within and among many systems.</td>
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<td>Systems move toward stable states.</td>
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<tr>
<td>Stability in an ecosystem can be disrupted by natural or human interactions.</td>
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<tr>
<td>Human activities, such as the burning of fossil fuels, affect the global climate.</td>
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<tr>
<td>Global climate models used to predict changes continue to be improved</td>
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<tr>
<td>Discoveries about the global climate system are ongoing and continually needed.</td>
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<tr>
<td>Effective use of digital tools assists in gathering and managing information.</td>
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<tr>
<td>Information accessed through the use of digital tools assists in generating solutions and making decisions.</td>
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<tr>
<td>Knowledge and understanding of human, cultural, and societal values are fundamental when utilizing technology systems and products in the global society.</td>
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<tr>
<td>The designed world is the product of a design process that provides the means to convert resources into products and systems.</td>
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<tr>
<td>Understanding the development of scientific ideas is essential for building scientific knowledge.</td>
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<tr>
<td>Technology evolves at an ever accelerating pace based on the needs and wants of society, and is influenced by cultural, political, and environmental values and constraints</td>
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<tr>
<td>Scientific inquiry involves asking scientifically oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.</td>
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(Will include but not be limited to these)

- How do science and technology influence each other?
- What safety rules are general and what are situation-specific?
- Are there ways to circumvent physical and social constraints when using technology?
- What do we mean in science when we say that we stand on the shoulders of giants?
- How do science and technology influence each other?
- How is technology both a cause and result of scientific activity?
- How does society respond to and influence scientific activity?
- What are the effects of technology on skills and knowledge required by the workforce?
- What is the nature of interaction between science, technology and society?
- How do some technological advances and capabilities create ethical and economic dilemmas for society?

<table>
<thead>
<tr>
<th>NJCCCS 2009 Standards</th>
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<tbody>
<tr>
<td><strong>5.1 Science Practices</strong></td>
</tr>
<tr>
<td><strong>A. Understand Scientific Explanations:</strong> Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.</td>
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<tr>
<td><strong>B. Generate Scientific Evidence Through Active Investigations:</strong> Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.</td>
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<tr>
<td><strong>C. Reflect on Scientific Knowledge:</strong> Scientific knowledge builds on itself over time.</td>
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<tr>
<td><strong>D. Participate Productively in Science:</strong> The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.</td>
</tr>
<tr>
<td><strong>5.2 C. Forms of Energy:</strong> Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.</td>
</tr>
<tr>
<td><strong>5.2 D. Energy Transfer and Conservation:</strong> The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.</td>
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<tr>
<td><strong>5.3 C. Interdependence:</strong> All animals and most plants depend on both other organisms and their environment to meet their basic needs.</td>
</tr>
<tr>
<td><strong>5.3 D. Heredity and Reproduction:</strong> Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.</td>
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<tr>
<td><strong>5.3 E. Evolution and Diversity:</strong> Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.</td>
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<tr>
<td><strong>5.3 F. Climate and Weather:</strong> Earth’s weather and climate systems are the result of complex interactions between land, ocean, ice, and atmosphere.</td>
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<tr>
<td><strong>8.1 E Research and Information Literacy</strong></td>
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<tr>
<td><strong>8.1 F. Critical Thinking, Problem Solving, and Decision-Making</strong></td>
</tr>
<tr>
<td><strong>8.2 C. Technological Citizenship, Ethics, and Society</strong></td>
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</tbody>
</table>
8.2 G The Designed world

9.1 Critical Thinking and Problem Solving
9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
9.1.12.A.4 (Optional) Justify problem-solving strategies used in the development of a particular innovative product or practice in the United States and in another country.
9.1 Creativity and Innovation
9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
9.1 Accountability, Productivity, and Ethics
9.1.12.F.1 Explain the impact of current and emerging technological advances on the demand for increased and new types of accountability and productivity in the global workplace.
9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
9.1.12.F.5 Formulate an opinion regarding a current workplace or societal/ethical issue based on research.
9.1.12.F.6 Relate scientific advances (e.g., advances in medicine) to the creation of new ethical dilemmas.
9.3 Career Awareness, Exploration, and Preparation: All students will apply knowledge about and engage in the process of career awareness, exploration, and preparation in order to navigate the globally competitive work environment of the information age.

Model Units of Study

Unit 1 Research task

<table>
<thead>
<tr>
<th>Objective</th>
<th>Knowledge and Skills</th>
<th>Learning Activities</th>
<th>Assessments</th>
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<tbody>
<tr>
<td>To complete a research task that identifies how society drives science to develop new technologies; or that identifies how science drives society’s use of technology.</td>
<td>SWBAT evaluate print and electronic resources</td>
<td>LMS-led lesson/discussion on evaluation websites. Students work independently on a Web Evaluation Worksheet.</td>
<td>Web Evaluation Worksheet</td>
</tr>
<tr>
<td>To utilize the library to locate quality print and web resources to address a research question.</td>
<td>SWBAT take notes and draw conclusions.</td>
<td>LMS-led discussion on notetaking and sources referenced. Students work independently on research, using a Notetaking Graphic Organizer.</td>
<td>Notetaking Graphic Organizer</td>
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<tr>
<td></td>
<td>SWBAT reference sources appropriately.</td>
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<td>References</td>
</tr>
<tr>
<td></td>
<td>SWBAT apply new learnings to</td>
<td></td>
<td>Technology-rich product and presentation.</td>
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</table>
To collect research and synthesize into a technology-rich product and presentation.

the creation of a technology-rich podcast.

LMS-led instruction on using podcast.

Student presentations.

Suggested Library Activities

Website evaluation

Notetaking Graphic Organizer

Podcast

Students will explore new technologies and how science benefits from and adapts to fit new scientific developments. Working independently, students will choose one of three suggested topics to research. Students will synthesize their research to create a podcast that describes how the topic showcases the complex relationship between science, technology, and society. In the final project, students will consider how science has benefited from advances in technology and how, in turn, scientific advances benefit our society.

Prior to visiting the library, students will select one of three suggested topics:

1.) Athletics (concussion prevention with improved helmet designs, sneaker improvements)
2.) Mobile technology (Google Glass, keyboard design, eye tracking software)
3.) Biomedical advances (cochlear implants, nano medicine)

As a class, students will visit the library to receive instruction from the librarian as follows:

**Day 1: Researchable Question, Website Evaluation & Source Citation**

Students will arrive in the library with their main topic and area of focus already determined. From this focus, the librarians will teach students how to craft a researchable question. The librarians will teach a lesson on how to evaluate a website, modeling how to use the provided Website Evaluation Checklist. Students examine a hoax website using the Website Evaluation Checklist to learn strategies for resource selection from the open web. Students will locate a website related to their selected topic and complete a Website Evaluation Checklist to demonstrate that they can apply what they have learned. The librarians will close the lesson by teaching the students how to generate a reference (using an approved scientific reference style) for the selected website.

**Day 2: Database Research & Notetaking Skills**

The librarians will demonstrate two subscription databases (Facts on File Science Online and Proquest) highlighting how these tools can best help student researchers. Using a Notetaking Graphic Organizer, the librarians will scaffold how to approach notetaking to best answer their researchable question. Students will complete the Graphic Organizer to show research progress. The librarians will close the lesson by teaching students how to locate the reference for a database article.

**Day 3: Research**

Students will continue their research with support from the classroom teacher and the librarians. The students will complete the Notetaking Graphic Organizer using at least one website and two database articles.

**Day 4: Research & Synthesizing into a Podcast Script**

Students will finalize their research with support from the classroom teacher and the librarians. The students will use the completed Notetaking Graphic Organizers to create and podcast script using the podcast script graphic organizer.

**Day 5:**
**Introduction to Podcast**
The librarians will demonstrate how to use GarageBand to create the final podcast. The librarian will support students as they begin to record and create the final project.

**Day 6: Podcast Production**
The librarians will support students as they continue to use GarageBand to record and create the final project.

**Day 7: Podcast Conclusion**
The librarians will support students as they complete the podcasts and will oversee saving of the projects to the class flash drive. Completed projects will be graded according to the Podcast Rubric.

**Day 8: Podcast Presentations**


### Unit 2 Alternative Energy Sources

<table>
<thead>
<tr>
<th>Objective</th>
<th>Knowledge and Skills</th>
<th>Learning Activities</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>To recognize the resources we use everyday in our lives.</td>
<td>SWBAT define the term resource and list examples from their own lives.</td>
<td>Teacher-led instruction on renewable and non-renewable resources, and alternative energy sources.</td>
<td>Article on alternative energy source where students discuss the pros and cons of using that type.</td>
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<tr>
<td>To understand the difference between renewable and non-renewable resources.</td>
<td>SWBAT explain the difference between a renewable resource and nonrenewable resource.</td>
<td>Web quest on alternative energy forms</td>
<td>Pod cast on Specific Type of Energy (Commercial)</td>
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<tr>
<td>To evaluate new energy sources based on several factors.</td>
<td>SWBAT list types of renewable resources, and discuss how and where they are developed.</td>
<td>Renew-a bean Activity: Activity that demonstrates how quickly non-renewable resources will be depleted versus renewable.</td>
<td>Quiz</td>
</tr>
<tr>
<td>To understand personal energy consumption, and explore ways to conserve energy.</td>
<td>SWBAT evaluate the types of alternative energy sources based on cost, environmental factors, and availability.</td>
<td>Ecological Footprint/Energy Audit</td>
<td>Review Worksheet</td>
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<td>SWBAT to evaluate pros and cons on new and emerging</td>
<td>Powering a classroom by wind investigation</td>
<td>Investigative Project on Hybrid/Electric Cars versus</td>
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<td>Video: who killed the Electric Car;</td>
<td>Develop action plan to make schools, houses, or communities more energy efficient</td>
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<td>Energy-ville game: Students will power a city using alternative forms of energy. They must use their</td>
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### Unit 3 Pharmaceuticals and Prescription drugs

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<tr>
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<th><strong>Learning Activities</strong></th>
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</table>
| To educate students on the history, growth, and social issues associated with the pharmaceutical industry and prescription drugs. | - The origins of pharmacies (holistic medicine, apothecaries, early manufacturing)  
- Classifications of drugs (ethical, generic, prescription, OTC, off-label, illicit)  
- What makes a drug “good”, “bad”, “safe”? | - Reading “History of Pharmacy” packet  
- PPT and Lecture, discussions (think-pair-share, small group discussions and whole class discussions),  
- Lab – fat-soluble vs. water-soluble | - Analysis questions based off of packet  
- Critical thinking questions (individual and group written responses, formative questions in classes)  
- Analysis questions from lab |

**References:**

- [http://kidsahead.com/subjects/2-wind-energy/activities](http://kidsahead.com/subjects/2-wind-energy/activities)
- [www.energyville.com](http://www.energyville.com)
- [http://www.youtube.com/watch?v=QKHAR6X3Nnw](http://www.youtube.com/watch?v=QKHAR6X3Nnw)
- [http://myfootprint.org/](http://myfootprint.org/)
- [http://www.altenergy.org/](http://www.altenergy.org/)

Students will view the cartoon version of the Lorax (25 minutes), and discuss how the Lorax depicts the current global energy crisis. Teacher gives the students a few questions to answer as they view the “Lorax”. At the end, teacher leads a discussion about how the truffula trees can represent our current non-renewable resources. Teacher also asks other questions of how can we apply the movie to our own lives and current environment.
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<tr>
<td>Explain the ever-increasing atmospheric [CO$_2$], including changes in atmosphere and oceans</td>
<td>Knowledge</td>
<td>Graphing atmospheric [CO$_2$] and ocean pH levels on Excel</td>
<td>Graphs of CO$_2$ concentration and ocean pH</td>
</tr>
<tr>
<td>Illustrate graphically the increase in [CO$_2$] in the atmosphere</td>
<td>Sources and effects of CO$_2$ in atmosphere</td>
<td>Introduction: Using graph paper to estimate %’s of various gases by filling in boxes with colors, then students</td>
<td>Labeling a CO$_2$ pressure-temp phase diagram</td>
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<tr>
<td>Draw and label a carbon</td>
<td>Sources and effects of CO$_2$ in oceans</td>
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<td>Two Papers</td>
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<td></td>
<td>Uses for CO$_2$</td>
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**Unit 4 Carbon-di-oxide levels in the atmosphere**

**Suggested Lab. Activities**

Chromatography Lab for common pain relievers

Clinical Trials Lab in class (perform fake single-blind, double-blind studies – use NIH ethics materials as resources)
Describe uses of CO\textsubscript{2}:
beverages, fire extinguisher, supercritical fluid caffeine extraction, refrigeration, other.

Read and label a carbon dioxide pressure-temperature phase diagram

Skills
Excel – graphing
Reading a graph (CO\textsubscript{2} pressure-temperature phase diagram)

are given actual %’s (This will show how small the concentration of CO\textsubscript{2} is and will probably surprise them.)

• researching one of the uses of CO\textsubscript{2} (students pick)
• researching one of the anthropogenic sources of CO\textsubscript{2} (students pick)

One Presentation-students will present one of the papers that they wrote
Quiz on CO\textsubscript{2} uses and sources

Suggested Lab. Activities

1. Bubbling CO\textsubscript{2} into a slightly basic solution containing phenolphthalein (models acidification of oceans)
2. Produce CO\textsubscript{2} in lab using yeast and sugar. Could be done overnight in a sealed 1L or 2L bottle. Gas could be tested by pouring it on a candle flame. (shows fire extinguishing properties)
3. Dry ice activity

References
Ocean acidity data-link
http://www.epa.gov/climatechange/science/indicators/oceans/acidity.html

CO2 data-below

Unit 5 Bioethics

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<tbody>
<tr>
<td>To recognize the principals of ethical thinking</td>
<td>SWBAT explain that ethics is a part of daily life that can be most simply explained as the science of morality. What should I do?</td>
<td>Teacher-led class discussion regarding societal ethics versus personal morals.</td>
<td>Oral presentation of current news article dealing with an ethical issue.</td>
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<td>To define ethics as a driving force in society</td>
<td>SWBAT describe how ethics apply to our behavior within society.</td>
<td>Teacher-led discussion regarding specific behavior that is considered “good” versus “bad” by society.</td>
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<td>To evaluate scientific progress as it changes the world with regard to the individual and society as a whole.</td>
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</table>

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| SWBAT model real-life ethical situations. |
| SWBAT discriminate between facts and values. |
| SWBAT predict the effects of opposing ethical viewpoints. |

and the relevant facts.

Read op-ed piece in news publication and comment on the ethical considerations of the piece.

Students choose an issue that they personally feel strongly about. For example, should animals be used for research?

Students research to find relevant facts and recognize the positive aspects of the issue along with their reasoning against it.

Students will defend their personal ethics both orally and in writing.

Case studies

Role playing

Debates
Ask students to identify an instance within the past week in which they were faced with an ethical dilemma. What questions did they ask themselves to help them make their final decision regarding their choice?

Teacher identifies ethical problems of interest to the students and picks one or two for further exploration. For example, after finding out that students are interested in the use of performance enhancing drugs by professional athletes, class discussion regarding such issues as performance enhancing drugs and their effects on the individual, the team on which the player performs, the fans emotionally and financially invested in the sport.

Activities developed by the Department of Bioethics at the NIH Clinical Center. Activities are developed around the following topics, but can be adapted to include those scientific ethical dilemmas that do not involve biology.

Examples:
Personalized medicine
Who receives limited doses of vaccine
Donation of organs, such as kidneys, for money
Decision on who receives organ transplant
Obama care
Genetic testing
GMO foods
Anti-drone movement
Nanotechnology
Euthanasia
Animal Testing

References:
"Center for Ethical Deliberation." Center for Ethical Deliberation, 27 May 2013 <http://mcb.unco.edu/ced/points.cfm>.


Unit 6 Energy Sources and Transformation of Energy

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<th>Learning Activities</th>
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<tr>
<td>To identify current sources of energy and alternative sources that are being researched.</td>
<td>SWBAT explain the Law of Conservation of Mass and Energy and understand that useful energy cannot be produced without coming from somewhere.</td>
<td>Review of physics terms that were learned in previous courses: mass, speed, potential energy, kinetic energy, friction, current, power, etc.</td>
<td>Prepare a presentation describing the advantages, disadvantages, current state of research, environmental impact, and cost effectiveness of one particular energy technology.</td>
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<tr>
<td>To recognize the need for research into this area.</td>
<td>SWBAT explain the Second Law of Thermodynamics in the sense that all processes produce waste energy (energy that is not in a useful form).</td>
<td>Short problem sets to practice calculating values from the equations.</td>
<td>Take part in a debate, taking the pro or con side of funding one of the emerging energy technologies.</td>
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<tr>
<td>To understand the ramifications of not finding alternative sources of energy.</td>
<td>SWBAT explain the basic science that underlies current methods of producing useful energy.</td>
<td>Use the U.S. Department of Energy’s website to investigate emerging methods of energy production. (U.S. Department of Energy’s website: <a href="http://www.eere.energy.gov/basics/">http://www.eere.energy.gov/basics/</a>)</td>
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<td></td>
<td>SWBAT perform</td>
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</table>
simple calculations to determine how much energy is needed or is used in everyday processes and to determine the efficiency of the methods studied.
Sample equations that might be employed: \( KE = \frac{1}{2} mv^2 \); \( PE_g = mgh \); \( P = W/t \); \( P = IV \);
\( W_{\text{eng}} = Q_H - Q_L \); efficiency = output / input

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<tr>
<td>Slide a block down a ramp. Calculate initial potential energy and final kinetic energy to show losses of energy to heat, due to friction.</td>
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<tr>
<td>Use a hand-crank generator to show that rotating a loop of wire inside a magnetic field generates current.</td>
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<tr>
<td>Build a basic motor to show that a loop of wire with current will experience a torque from an external magnetic field.</td>
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</table>
HS STEM Courses
Overview:

Course Description: Biotechnology is a semester long, lab-based course designed to introduce students to the use of biological processes or organisms to manufacture products intended to improve the quality of human life. Biotechnology is a recent term that applies to ancient techniques such as brewing and selective breeding as well as to current techniques in genetic engineering. Topics include construction of recombinant DNA, genetically modified organisms, monoclonal antibodies, genetic testing, bioremediation, careers and ethics. Concepts will be introduced and reinforced with a variety of experiments, activities and demonstrations. Students will come to understand that biotechnology not only applies to their daily lives but will be important to them in their future.

Grades will be based on activities, presentations, laboratory reports, homework quizzes and exams. There will be a comprehensive final exam at the end of the semester. Students will be required to upload some assignments to sites such as turnitin, edmodo and our class wiki.
Biotechnology Curriculum

**Essential Questions:**
What is Biotechnology? What role does it play in the lives of 21st century humans?

**Enduring Understanding:**
Biotechnology is the use of biological processes or organisms to manufacture products in order to improve the quality of human life.

- The term biotechnology is recent but applies to ancient techniques such as brewing and selective breeding as well as to current techniques in genetic engineering.
- Biotechnology plays a role in shaping and analyzing medical, agricultural, pharmaceutical, environmental and ethical influences in human lives.

Students will be able to:
- Explain the meaning of biotechnology in both past and present terms.
- Give examples of biotechnology as it applies to their present life and how it may apply to their future.
- Identify the biological molecules involved in the science of biotechnology.
- Demonstrate an ancient form of biotechnology by making cheese using a bacterial protein.

**Essential Question:**
What biological organisms are used or exploited for purposes of biotechnology?

**Enduring Understanding:**
Microorganisms, mainly bacteria, have been used for biotechnology. Yeasts, plant, insect and animal cells as well as viruses also play roles in some processes.

- Prokaryotic organisms, such as bacteria, are simpler to manipulate and were the first organisms used. Bacteria grow very quickly and therefore, make product quickly.
- Eukaryotic organisms, such as yeast and animals, are more complicated and are often more difficult to grow and maintain in the large quantities needed for production of gene products.
- In some cases, bacteria cannot perform all the steps needed to produce a functional protein.
- Some prokaryotes possess an extrachromosomal piece of DNA, the plasmid, which is often used to produce recombinant proteins.

Students will be able to:
- Describe cell structure and distinguish between prokaryotic and eukaryotic cells.
- Identify problems with using bacteria for production of complex, modified proteins.
- Suggest ways to overcome problems inherent with using bacteria.
- Observe exponential growth in a bacterial culture.

**Essential Questions:**
What is a gene? What is the structure of a gene? What are the products of genes? What is recombinant DNA and what role does it play in biotechnology?

**Enduring Understandings:**
Genes are discrete sequences of DNA that code for a specific protein. DNA is the molecule that defines each individual characteristic of all living things.

- The ability to isolate and extract specific DNA is key to modifying an organism’s traits to suit human needs.
- Recombinant DNA is created by combining DNA from two or more sources.
- Microorganisms enable the generation of recombinant DNA and hence recombinant proteins.
- Enzymes called restriction endonucleases cut DNA at specific sequences.
- Enzymes called ligases catalyze formation of covalent bonds between pieces of DNA.
- These two enzyme types, of microbial origin, are responsible for the construction of recombinant DNA molecules.

Students will be able to:
- Explain the Central Dogma of Biology and its importance in recombinant DNA technology.
- Model the structure of DNA and its replication.
- Identify types of mutations in DNA and how these mutations can be exploited.
- Use restriction enzyme specificity and DNA sequence information to locate areas of DNA that can be cut leaving sticky ends.
- Generate, on paper, recombinant DNA molecules.
- Use restriction endonucleases to cut bacterial DNA into fragments and then separate these fragments using agarose gel electrophoresis.
- Measure the number of base pairs of each fragment by extrapolation.
- Transform *E. coli* with a recombinant plasmid.
- Grow these *E. coli* on nutrient agar and identify which *E. coli* have been transformed based on production of a green fluorescent jellyfish protein.
- Demonstrate use of selective growth media.

**Essential Question:** How can we use our knowledge of gene manipulation to enhance the identification and treatment of medical conditions?

**Enduring Understandings:**
- Scientists are able to create unique probes to identify specific sequences of DNA.
Cells can be engineered to produce specific antibodies for protein purification and vaccine production.

Transgenic animals ("pharm" animals) and transgenic plants are used to produce human pharmaceutical proteins.

Students will be able to:

▪ Describe how biomarker technology allows for more specific identification of diseases as well as targeted treatment of certain cancers.
▪ Use monoclonal antibodies to track the transmission of a simulated infectious virus.
▪ Employ gel electrophoresis to fingerprint viral DNA.
▪ Identify a current gene therapy that has the potential to treat and possibly cure a disease that is genetic in nature.
▪ Examine the design of bioartificial organs as temporary or permanent replacements to failed human organs.
▪ Explain how regenerative medicine can replace or regenerate human cells tissues or organs to enable normal function.
▪ Employ DNA chip technology to model personalized medicine - medical care based on the genetic information and family history of an individual.
▪ Describe the production of plant-based pharmaceutical proteins made using genetically engineered plants.

**Essential Question:** What is the role of biotechnology in fields other than medicine?

**Enduring understanding:**

- DNA offers important information about life that can provide technological advances in the fields of forensics, agriculture, animal husbandry, environment, and alternate energy sources.

Students will be able to:

▪ Differentiate between traditional selective breeding techniques and modern plant breeding.
▪ Clone a plant via plant tissue culture.
▪ Characterize techniques in selective animal breeding.
▪ Summarize the use of biotechnology in food production.
▪ Describe the role of DNA fingerprinting in forensic science.
▪ Explain the use of microbial fuel cells in production of biofuels.
▪ Use oil-eating bacteria to demonstrate bioremediation.
▪ Summarize the role of biotechnology in mining.

**Essential Question:**
What are some of the ethical implications of advances in Biotechnology?

**Enduring Understanding:**

- Advances in biotechnology create ethical dilemmas that require humans to make decisions based upon scientific knowledge and philosophical beliefs.
Students will be able to:
- Analyze the consequences of specific advances in biotechnology.
- Defend a position with regard to a specific ethical dilemma.

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<th>Genetic Cloning and Manipulation</th>
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<td>Genetically Modified Plants</td>
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<td>The Ethics of GMO Technology</td>
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**Syllabus**

**Genetics**
- Gene Size, number, differences among different organisms
- DNA-RNA-Protein (central dogma) (product – protein)
- Gene Expression
- Protein Folding
- DNA structure specifics
Making a Recombinant gene
  - Restriction enzymes, ligases
DNA amplification
  - Transformation
  - (PCR)
  - Pros and cons of PCR
DNA purification
  - Gel Electrophoresis – separates segments of DNA for identification
  - Research – forensics, tracing genetic background…
Relationship between DNA and Genes
Expression of recombinant proteins
  - Insulin, HGF – human cells
Applications of Biotech, Bioethics and Careers
  - Personalized medicine (breast cancer gene detection lab), DNA chip –
    Speaker/Webinar from Camden?

Microbiology

Before there was PCR, how would genes be amplified?
  - Microbes – list - yeast, protozoa, viruses, bacteria…
  - Bacterial Cells
  - Review of Bacterial Structure
  - Growth in Bacterial Populations – exponential growth
  - Problems with using bacteria for amplification
  - Yeast and its role in eukaryotic gene expression

Applications of Microorganisms

  - Enzymes production, and Applications of Enzymes
  - Cheese Making
  - Energy Resources (Biofuels)
  - Sewage Treatment (Bioremediation

Genetic Cloning and Manipulation

How do we get genes, and how do we get them in right location?
  - What is Intentional Genetic Modification and what is its purpose – distinguish
    between modification of an organism and not modification of the gene itself
  - Unintentional genetic modification (Antibiotic Resistance)
  - Molecular scissors and Glue (Sequence of Genes – find restriction enzyme- cut
    it out) -
  - Column Chromatography and Reintroduce Electrophoresis (to identify and
    separate it)
  - Gene Cloning Using Plasmids (insert it into bacteria, yeast)
  - Using Recombinant Bacteria and Transgenic Organisms (also pig heart valve in
    humans)
Applications
The Nature of GMOs – Golden Rice, Round Up Ready and BT organisms
The Ethics of GMO Technology

Specific Applications of Biotechnology in Medicine
How can we use our knowledge of gene manipulation to enhance the identification and treatment of medical conditions?
   Monoclonal Antibodies
   Antimicrobial Drugs
   Gene Therapy
   Gene Delivery Systems
   Stem Cells and Tissue Engineering
   Bioinformatics and Disease research
Overview:

**Course Description:** Biotechnology is a semester long, lab-based course designed to Overview of Engineering is a college-prep course for juniors and seniors who have an interest in majoring in engineering at a four-year college or university. This project-based learning course extends prior work in math, physics, and chemistry and applies it to engineering design problems and processes. Multiple areas will be explored including, but not limited to, the traditional disciplines of chemical, civil, electrical, and mechanical engineering. Additional design topics include cost analysis, ethics, and communications (oral and written). The course will assist students in making decisions on a prospective major as well as discussions on post-graduate opportunities in the work force and graduate education.
Overview of Engineering

Textbook: Various references will be used throughout the course.

Standards:

Similar to Advanced Placement (AP) courses, Overview of Engineering exceeds NJCCCS by the very nature of introducing and preparing the student who has successfully completed Physics and Chemistry for engineering study at the college level. Standard 8.2 provides a foundation for a unique, novel course such as Overview of Engineering. Additionally, Standards 5.1 Science Practices and 5.2 Physical Science apply to this course and are reinforced from previous science classes.

5.1 Science Practices
All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge.

5.2 Physical Science
All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

8.2 Technology Education, Engineering and Design
All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual, global society, and the environment.
Enduring Understandings

- Engineering systems impact every aspect of the world in which we live.
- The design process is a systematic approach to solving problems.
- Knowledge and understanding of human cultural and societal values are fundamental when designing engineering systems and products in the global society.
- Information literacy skills, research, data analysis and prediction are the basis for the effective design of engineering systems.
- Digital tools facilitate, but do not always replace, local and global communication and collaboration in designing products and systems.
- The designed world is the product of a design process that provides the means to convert resources into products and systems.
- There are four primary disciplines in Engineering – Chemical, Mechanical, Civil, and Electrical and there is considerable overlap among the different engineering disciplines.
- Significant collaboration among engineers, scientists and mathematicians exists, and the dividing lines among these professions are very often blurred.
- Engineers rely heavily on science and mathematics to complete projects.
- Engineers protect public safety, health, and welfare through use of science, mathematics, and design processes.
- Advances in design and product are the result of focused innovation, invention, testing and evaluation followed by redesign.
- All of the apparently available resources cannot always be counted upon to deliver output; therefore, engineers need to be able to determine how to maximize output.
- In order to maintain continual availability of essential public services (e.g., electricity, water, heating) we need a tremendous amount of infrastructure.
- There are errors and uncertainties in every measurement. All we can do is to try to ensure they are as small as possible and to have a reliable estimate of how large they are.
- The slope of and area under graphs have physical meaning.
- In all fields of engineering, the strength of materials and the processes that affect this play an important role in the design process.
- Power plants are governed by the laws of thermodynamics.
- The Law of Conservation of Momentum applies to any type of collision, which includes any type of vehicular accident.
- Polymers changed and continue to change the way we live our lives.
- A liquid applies a force to an object floating in it that opposes the force of gravity.
- Community noise has contributions from surface traffic, air traffic and rail. It has a negative impact on both physiological and psychological health.
- Above ground hazardous waste sites infiltrate soil and ground water affecting all life.
Essential Questions

- Why is it important to be able to estimate errors in measurement and minimize them?
- How do math and science relate to engineering?
- How does one define strength of materials in the engineering context?
- How does the relationship between stress and strain play an important role in engineering?
- What are the factors that affect the strength and mechanics of materials and how do they determine design options and choices?
- How can we determine the impact experienced during a car crash and minimize the effects on both the car and occupants?
- What role does friction play in engineering design and analysis?
- What are the skills and knowledge necessary to build and maintain a power plant?
- Why would energy (electricity) sources be placed in series or in parallel?
- What are the reasons for building a fossil fuel or an alternative energy power plant?
- What are the advantages and disadvantages of fossil fuels and alternative energy sources?
- How is it possible for a 40,000 ton ship to stay afloat as compared to a small rock that sinks?
- Why is it important to assess and control community noise levels?
- How can we control noise levels?
- How can we predict hazardous waste progression through soil and groundwater?
- What are some strategies that may be used to remediate hazardous waste sites to meet federal standards?
- What is a Code of Ethics?
- What does a four-year college engineering curriculum entail?
- Why study engineering?
- What careers are available for someone with an engineering degree?
Skills & Objectives

- Discuss basic principles of measurement including systems of units, significant figures, and standards of measurement.
- Use various tools in engineering measurement and design.
- Perform calculations and manipulate equations.
- Graph, analyze, and interpret data using standard engineering guidelines and practices.
- Review all projectile motion (two-dimensional motion) equations and apply them using statistics and error analysis.
- Create a stress-strain curve and derive various properties of materials from the graph.
- Apply Hooke’s Law to materials and relate it to the modulus of elasticity.
- Apply the Law of Conservation of Momentum to analyze two-object systems.
- Recognize the basic principles and laws concerning the conservation of energy and the exchange and transformation of energy.
- Describe the basic propulsion (steam) cycle.
- Identify the purposes and components of energy balances in a power plant.
- Create circuits with a load (e.g., light bulbs) and energy sources (e.g., batteries) in both parallel and series configurations and determine potential (voltage), currents, and equivalent resistance.
- Identify the basic considerations involved in designing a ship/boat.
- State Archimedes’ Principle and apply it to ship/boat design.
- Describe buoyancy and stability.
- Explain the relationship between draft, displacement, underwater volume, and the height of the center of buoyancy from the keel of a ship.
- Describe how the movements of weights affect a ship’s stability.
- Create contour lines on a map and relate them to the water table.
- Calculate and track groundwater flow using Darcy’s Law.
- Describe methods of hazardous waste site remediation including advantages and disadvantages.
- Examine and employ basic methods for project management and cost analysis.
- Discuss prerequisites for an incoming college engineering student.
- List and discuss the general courses required for a bachelor’s degree in the traditional engineering disciplines.
- Discuss career paths for an engineer including advanced education.
- Recognize creeds, codes, statutes, and rules as they apply to the professional practice of engineers.
- Continue to reinforce applicable skills and objectives from physics, chemistry, and math.
**Syllabus and Topics Covered**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Topic</th>
</tr>
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<tbody>
<tr>
<td>Hooke’s law measurement</td>
<td>Thermodynamics</td>
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<tr>
<td>Stress strain graphs</td>
<td>Steam Cycle</td>
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<tr>
<td>Pressure</td>
<td>Fossil fuels</td>
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<tr>
<td>Polymers – create and apply – using science and design process</td>
<td>Alternate Energy sources</td>
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<tr>
<td>Error Analysis</td>
<td>Fluids - Density, Buoyancy, Archimedes Principle</td>
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<tr>
<td>Crash Mechanics</td>
<td>Safety</td>
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<td>Projectile motion</td>
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<td>Velocity</td>
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<tr>
<td>Impulse</td>
<td>Darcy’s law</td>
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<td>Force</td>
<td>Engineering Ethics</td>
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<tr>
<td>Conservation of Momentum</td>
<td>Hazardous waste and site remediation</td>
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<tr>
<td></td>
<td>Cryptography (if time permits)</td>
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</tbody>
</table>
Advanced Placement
Advanced Placement Biology

Course Description:
Advanced Placement Biology is a rigorous and demanding college-level course. It is designed for students with an interest in science, biology, medicine or a related field. Advanced Placement Biology is laboratory-oriented, with an extraordinary amount of home study required. This course prepares students for the Advanced Placement Examination which all students are required to take.
Students are expected to complete a summer assignment given by the teacher. Advanced Placement Biology stresses college-level academics on a wide range of subject matter such as: cell physiology, biochemistry, metabolism, respiration, photosynthesis, genetics and animal anatomy and physiology. While students in Advanced Placement Biology study many of the topics of Biology I, they proceed with greater independence of thought and develop a great deal more insight into the realm of biology by engaging in a more rigid, more sophisticated approach to the topic under study. The overall instructional strategy approach is that of a first year college biology course. The curriculum meets and exceeds the topics required by the College Board for the Advanced Placement Biology Exam. This course uses texts that are used in Colleges and Universities. The student grades are based upon a sophisticated summer assignment, tests, homework, laboratory reports and clear communication of their understanding.

Goals:
This course is designed to be the equivalent of a college introductory biology course usually taken by biology majors during their first year. Some AP students, as college freshmen, are permitted to undertake upper-level courses in biology or to register for courses for which biology is a prerequisite. Other students may have fulfilled a basic requirement for a laboratory science course and will be able to undertake other courses to pursue their majors.

AP Biology should include the topics regularly covered in a college biology course for majors. The textbooks used for AP Biology should be those used by college biology majors and the labs done by AP students must be the equivalent of those done by college students.

The AP Biology course is designed to be taken by students after the successful completion of a first course in high school biology and one in high school chemistry. It aims to provide students with the conceptual framework, factual knowledge, and analytical skills necessary to deal critically with the rapidly changing science of biology.

The two main goals of AP Biology are to help students develop a conceptual framework for modern biology and to help students gain an appreciation of science as a process. The ongoing information explosion in biology makes these goals even more challenging. Primary emphasis in an AP Biology course should be on developing an understanding of concepts rather than on memorizing terms and technical details. Essential to this conceptual understanding are the following: a grasp of science as a process rather than as an accumulation of facts; personal experience in scientific inquiry; recognition of unifying themes that integrate the major topics of biology; and application of biological knowledge and critical thinking to environmental and social concerns.

The AP Biology Development Committee conducts college curriculum surveys of introductory biology
courses for biology majors and develops the AP Biology Examination so that it is representative of the topics covered by the survey group. Accordingly, goals have been set for percentage coverage of three areas: Molecules and Cells, 25%; Heredity and Evolution, 25% and Organisms and Populations, 50%. These three areas have been subdivided into major categories with percentage goals for each major category specified. The percentage goals should serve as a guide for designing an AP Biology course and may be used to apportion the time devoted to each category. The examination is constructed using the percentage goals as guidelines for question distribution.

12 Recommended Labs

1. Global Diffusion and Osmosis
2. Enzyme Catalysis
3. Mitosis and Meiosis
4. Plant Pigments and Photosynthesis
5. Cell Respiration
6. Molecular Biology
7. Genetics of Organisms
8. Population Genetics and evolution
9. Transpiration
10. Physiology of the Circulatory System
11. Animal Behavior
12. Dissolved Oxygen and Aquatic Primary Productivity
Advanced Placement Chemistry

Course Description:
Advanced Placement Chemistry is a rigorous and demanding college-level course. It is designed for students with an interest in science, medicine, engineering or a related field. Advanced Placement Chemistry is laboratory-oriented, with a substantial amount of home study required. This course prepares students for the Advanced Placement Examination which all students are required to take. Students are expected to complete a summer assignment given by the teacher. A.P. Chemistry is developed within a framework of concepts such as the chemical bond, the structure of matter, matter-energy relationships, the mole concept, equilibrium, chemical notation, periodicity, and aspects of organic and nuclear chemistry. While students in Advanced Placement Chemistry study many of the topics of Chemistry I, they proceed with greater independence of thought and develop a great deal more insight into the realm of chemistry by engaging in a more rigid, more sophisticated approach to the topic under study. The overall instructional strategy approach is that of a first year college chemistry course. The student grades are based upon tests, homework, lab reports, and clear communication of their understanding of the concepts taught. The student requesting A.P. Chemistry must possess a thorough working knowledge of algebraic principles.

Goals:
This course is designed to be the equivalent of the general chemistry course usually taken during the first college year. For some students, this course enables them to undertake, as freshmen, second-year work in the chemistry sequence at their institution or to register for courses in other fields where general chemistry is a prerequisite. For other students, the AP Chemistry course fulfills the laboratory science requirement and frees time for other courses. AP Chemistry should meet the objectives of a good general chemistry course. Students should attain a depth of understanding of fundamentals and a reasonable competence in dealing with chemical problems. The course should contribute to the development of the students' abilities to think clearly and to express their ideas, orally and in writing, with clarity and logic. The college course in general chemistry differs qualitatively from the usual first secondary school course in chemistry with respect to the kind of textbook used, the topics covered, the emphasis on chemical calculations and the mathematical formulation of principles, and the kind of laboratory work done by students. Quantitative differences appear in the number of topics treated, the time spent on the course by students, and the nature and the variety of experiments done in the laboratory. Secondary schools that wish to offer an AP Chemistry course must be prepared to provide a laboratory experience equivalent to that of a typical college course.

To develop the requisite intellectual and laboratory skills, AP Chemistry students need adequate classroom and laboratory time. It is expected that a minimum of 290 minutes per week will be allotted for an AP Chemistry course. Of that time, a minimum of 90 minutes per week, preferably in one session, should be spent in the lab. (Time devoted to class and laboratory demonstrations should not be counted as part of the laboratory period.) In addition, students will probably need to spend at least five hours a week studying outside of class.

The AP Chemistry course is designed to be taken after the completion of a first course in high school chemistry. It is strongly recommended that credit in a first-year high school chemistry course be a prerequisite for enrollment in an AP Chemistry class. In addition, the recommended mathematics
prerequisite for an AP Chemistry class is the successful completion of a second-year algebra course. The advanced work in chemistry should not displace any other part of the student's science curriculum. It is highly desirable that a student have a course in secondary school physics and a four-year college preparatory program in mathematics.

**Topic Outline**

The following outline for an AP Chemistry course is intended to be a guide to the level and breadth of treatment expected rather than to be a syllabus. The percentage after each major topic indicates the approximate proportion of multiple-choice questions on the exam that pertain to the topic.

I. Structure of Matter (20%)

- Atomic theory and atomic structure
  - Evidence for the atomic theory
  - Atomic masses; determination by chemical and physical means
  - Atomic number and mass number; isotopes
  - Electron energy levels: atomic spectra, quantum numbers, atomic orbitals
  - Periodic relationships including, for example, atomic radii, ionization energies, electron affinities, oxidation states

- Chemical bonding
  - Binding forces
    - Types: ionic, covalent, metallic, hydrogen bonding, van der Waals (including London dispersion forces)
    - Relationships to states, structure, and properties of matter
    - Polarity of bonds, electronegativities
  - Molecular models
    - Lewis structures
    - Valence bond: hybridization of orbitals, resonance, sigma and pi bonds
    - VSEPR
  - Geometry of molecules and ions, structural isomerism of simple organic molecules and coordination complexes; dipole moments of molecules; relation of properties to structure
  - Nuclear chemistry: nuclear equations, half-lives, and radioactivity; chemical applications

II. States of Matter (20%)

- Gases
  - Laws of ideal gases
    - Equation of state for an ideal gas
    - Partial pressures
  - Kinetic-molecular theory
    - Interpretation of ideal gas laws on the basis of this theory
    - Avogadro's hypothesis and the mole concept
    - Dependence of kinetic energy of molecules on temperature
    - Deviations from ideal gas laws

- Liquids and solids
  - Liquids and solids from the kinetic-molecular viewpoint
  - Phase diagrams of one-component systems
  - Changes of state, including critical points and triple points
  - Structure of solids; lattice energies

Solutions
Types of solutions and factors affecting solubility
Methods of expressing concentration (The use of normalities is not tested.)
Raoult's law and colligative properties (nonvolatile solutes); osmosis
Non-ideal behavior (qualitative aspects)

III. Reactions (35-40%)
Reactions types
Acid-base reactions; concepts of Arrhenius, Brönsted-Lowry, and Lewis; coordination complexes; amphoterism
Precipitation reactions
Oxidation-reduction reactions
Oxidation number
The role of the electron in oxidation-reduction
Electrochemistry: electrolytic and galvanic cells; Faraday's laws; standard half-cell potentials; Nernst equation; prediction of the direction of redox reactions

Stoichiometry
Ionic and molecular species present in chemical systems: net ionic equations
Balancing of equations including those for redox reactions
Mass and volume relations with emphasis on the mole concept, including empirical formulas and limiting reactants

Equilibrium
Concept of dynamic equilibrium, physical and chemical; Le Chatelier's principle; equilibrium constants
Quantitative treatment
Equilibrium constants for gaseous reactions: \(K_p, K_c\)
Equilibrium constants for reactions in solution
Constants for acids and bases; \(pK, pH\)
Solubility product constants and their application to precipitation and the dissolution of slightly soluble compounds
Common ion effect; buffers; hydrolysis

Kinetics
Concept of rate of reaction
Use of experimental data and graphical analysis to determine reactant order, rate constants, and reaction rate laws
Effect of temperature change on rates
Energy of activation; the role of catalysts
The relationship between the rate-determining step and a mechanism

Thermodynamics
State functions
First law: change in enthalpy; heat of formation; heat of reaction; Hess's law; heats of vaporization and fusion; calorimetry
Second law: entropy; free energy of formation; free energy of reaction; dependence of change in free energy on enthalpy and entropy changes
Relationship of change in free energy to equilibrium constants and electrode potentials

IV. Descriptive Chemistry (10-15%)
Knowledge of specific facts of chemistry is essential for an understanding of principles and concepts. These descriptive facts, including the chemistry involved in environmental and societal issues, should not be isolated from the principles being studied but should be taught throughout
the course to illustrate and illuminate the principles. The following areas should be covered:

Chemical reactivity and products of chemical reactions

Relationships in the periodic table: horizontal, vertical, and diagonal with examples from alkali metals, alkaline earth metals, halogens, and the first series of transition elements

Introduction to organic chemistry: hydrocarbons and functional groups (structure, nomenclature, chemical properties). Physical and chemical properties of simple organic compounds should also be included as exemplary material for the study of other areas such as bonding, equilibria involving weak acids, kinetics, colligative properties, and stoichiometric determinations of empirical and molecular formulas.

V. Laboratory (5-10%)
The differences between college chemistry and the usual secondary school chemistry course are especially evident in the laboratory work. The AP Chemistry Exam includes some questions based on experiences and skills students acquire in the laboratory: making observations of chemical reactions and substances; recording data; calculating and interpreting results based on the quantitative data obtained; and communicating effectively the results of experimental work.

Colleges have reported that some AP candidates, while doing well on the exam, have been at a serious disadvantage because of inadequate laboratory experience. Meaningful laboratory work is important in fulfilling the requirements of a college-level course of a laboratory science and in preparing a student for sophomore-level chemistry courses in college.

Because chemistry professors at some institutions ask to see a record of the laboratory work done by an AP student before making a decision about granting credit, placement, or both, in the chemistry program, students should keep reports of their laboratory work that can be readily reviewed.

Chemical Calculations
The following list summarizes types of problems either explicitly or implicitly included in the topic outline. Attention should be given to significant figures, precision of measured values, and the use of logarithmic and exponential relationships. Critical analysis of the reasonableness of results is to be encouraged.

1. Percentage composition
2. Empirical and molecular formulas from experimental data
3. Molar masses from gas density, freezing-point, and boiling-point measurements
4. Gas laws, including the ideal gas law, Dalton's law, and Graham's law
5. Stoichiometric relations using the concept of the mole; titration calculations
6. Mole fractions; molar and molal solutions
7. Faraday's law of electrolysis
8. Equilibrium constants and their applications, including their use for simultaneous equilibria
9. Standard electrode potentials and their use; Nernst equation
10. Thermodynamic and thermochemical calculations
11. Kinetics calculations
Advanced Placement Environmental Science

Course Description:
The Advanced Placement Environmental Science course is an introductory college course. Students should have an interest in the environment, natural sciences, or engineering. Environmental science is interdisciplinary; it embraces a wide variety of topics from different areas of study. Admission to an AP course ordinarily depends on the student’s interest in the subject as well as on a superior record. AP Environmental Science, a rigorous science course with several prerequisites, is no exception. This course prepares students to take the Advanced Placement Examination which all students are required to take.

Students must complete a summer assignment given by the teacher. The course’s major topics define the scope of both the course and the AP exam. Topics include: Earth Systems and Resources (fundamental principles and concepts), The Living World (ecosystems and processes), Population, Land and Water Use, Energy Resources and Consumption (fossil fuels and alternative sources), Pollution, and Global Change. The course includes a laboratory and investigation component. Students are expected to have a strong math background to handle quantitative analysis required in the course. Students’ grades are based upon a variety of assessments, including, but not limited to: activities, laboratory work and reports, homework, and tests.

Goals:
The goal of the AP Environmental Science course is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving and/or preventing them.

Environmental science is interdisciplinary; it embraces a wide variety of topics from different areas of study. Yet there are several major unifying constructs, or themes, that cut across the many topics included in the study of environmental science. The following themes provide a foundation for the structure of the AP Environmental Science course.

1. Science is a process.
   1.1. Science is a method of learning more about the world.
   1.2. Science constantly changes the way we understand the world.

2. Energy conversions underlie all ecological processes.
   2.1. Energy cannot be created; it must come from somewhere.
   2.2. As energy flows through systems, at each step more of it becomes unusable.

3. The Earth itself is one interconnected system.
   3.1. Natural systems change over time and space.
   3.2. Biogeochemical systems vary in ability to recover from disturbances.

4.1. Humans have had an impact on the environment for millions of years.

4.2. Technology and population growth have enabled humans to increase both the rate and scale of their impact on the environment.

5. Environmental problems have a cultural and social context.
   5.1. Understanding the role of cultural, social and economic factors is vital to the development of solutions.

6. Human survival depends on developing practices that will achieve sustainable systems.
   6.1. A suitable combination of conservation and development is required.

7. Management of common resources is essential.

**Topic Outline**
The following outline of major topics serves to describe the scope of the AP Environmental Science course and exam. The Development Committee has reorganized the outline in order to better present the course content in terms of major concept areas. However, it is important to note that this reorganized outline does **NOT** represent a change in the content of the course or the exam. The order of topics in the outline holds no special significance, since there are many different sequences in which the topics can be appropriately addressed in the course. The percentage after each major topic heading shows the approximate proportion of multiple-choice questions on the exam that pertain to that heading; thus the percentage also indicates the relative emphasis that should be placed on the topics in the course.

**I. Earth Systems and Resources (10-15%)**
- Earth Science Concepts  (Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)
- The Atmosphere  (Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere-ocean interactions; ENSO)
- Global Water Resources and Use  (Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)
- Soil and Soil Dynamics  (Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

**II. The Living World (10-15%)**
- Ecosystem Structure  (Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)
- Energy Flow  (Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)
- Ecosystem Diversity  (Biodiversity; natural selection; evolution; ecosystem services)
- Natural Ecosystem Change  (Climate shifts; species movement; ecological succession)
- Natural Biogeochemical Cycles  (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

**III. Population (10-15%)**
- Population Biology Concepts  (Population ecology; carrying capacity; reproductive strategies; survivorship)
- Human Population  
  - Human population dynamics  (Historical population sizes; distribution; fertility rates;
growth rates and doubling times; demographic transition; age-structure diagrams)
Population size (Strategies for sustainability; case studies; national policies)
Impacts of population growth (Hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use (10-15%)
Agriculture
Feeding a growing population (Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)
Controlling pests (Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

Forestry (Tree plantations; old growth forests; forest fires; forest management; national forests)
Rangelands (Overgrazing; deforestation; desertification; rangeland management; federal rangelands)

Other Land Use
Urban land development (Planned development; suburban sprawl; urbanization)
Transportation infrastructure (Federal highway system; canals and channels; roadless areas; ecosystem impacts)
Public and federal lands (Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
Land conservation options (Preservation; remediation; mitigation; restoration)

Sustainable land-use strategies

Mining (Mineral formation; extraction; global reserves; relevant laws and treaties)
Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption (10-15%)
12. Energy Concepts (Energy forms; power; units; conversions; Laws of Thermodynamics)
13. Energy Consumption
   a. History (Industrial Revolution; exponential growth; energy crisis)
   b. Present global energy use
   c. Future energy needs
14. Fossil Fuel Resources and Use (Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/disadvantages of sources)
15. Nuclear Energy (Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)
16. Hydroelectric Power (Dams; flood control; salmon; silting; other impacts)
17. Energy Conservation (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)
18. Renewable Energy (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution (25-30%)
   • Pollution Types
Air pollution (Sources-primary and secondary; major air pollutants; measurement units; smog; acid deposition-causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
Noise pollution (Sources; effects; control measures)
Water pollution (Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
Solid waste (Types; disposal; reduction)

- Impacts on the Environment and Human Health
  Hazards to human health (Environmental risk analysis; acute and chronic effects; dose response relationships; air pollutants; smoking and other risks)
  Hazardous chemicals in the environment (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)
- Economic Impacts (Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. Global Change (10-15%)
Stratospheric Ozone (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)
Global Warming (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)
Loss of Biodiversity
  Habitat loss; overuse; pollution; introduced species; endangered and extinct species
  Maintenance through conservation
  Relevant laws and treaties
Advanced Placement Physics B
(Algebra Trigonometry based)

Course Description:
Advanced Placement Physics B is a demanding college-level, laboratory-based course. It is designed for students who have a high interest in physics. Although students planning on a college major in science, engineering, mathematics, or a related field would still have to take a calculus-based physics course (a course equivalent to AP Physics C), AP Physics B provides excellent preparation for the above college majors including pre-med programs. Students who complete AP Physics B may later choose to take AP Physics C for full credit. This course covers a broad spectrum of topics, including: linear motion, forces, projectile motion, impulse and momentum, work and energy, circular motion and universal gravitation, fluids, mechanical waves and oscillations, thermodynamics, light, geometric optics, electrostatics, circuits, magnetism, and modern physics. Students’ grades are based upon a variety of assessments, including, but not limited to: activities, lab work and reports, homework, and tests. Students must complete a summer assignment given by the teacher. AP Physics B prepares students to take the Advanced Placement Examination which all students are required to take. This is an intensive course that requires an extraordinary amount of independent study on the part of the student. We will make extensive use of mathematics to study the patterns that govern our natural world. Students must be proficient in algebra, geometry, and must become proficient in trigonometry to succeed.

Goals:
This course provides a systematic introduction to the main principles of physics and emphasizes the development of conceptual understanding and problem-solving ability using algebra and trigonometry, but rarely calculus. In most colleges, this is a one-year terminal course including a laboratory component and is not the usual preparation for more advanced physics and engineering courses. However, the B course provides a foundation in physics for students in the life sciences, premedicine, and some applied sciences, as well as other fields not directly related to science.

Topic Outline:
Physics B seeks to be representative of topics covered in similar college courses, as determined by periodic surveys. Accordingly, goals have been set for percentage coverage of five general areas. See the topic outline for each area:

Many colleges and universities include additional topics such as special relativity. Some AP teachers may wish to add such supplementary material to an AP Physics B course. Many teachers have found that a good time to do this is late in the year, after the AP Exams have been given.

Note: For course topics see chart comparing Physics B and Physics C following the “C” curriculum statements.
Advanced Placement Physics C
(Calculus based)

Course Description:
Advanced Placement Physics is a rigorous and demanding college-level course. It is designed for students with an interest in science, medicine, engineering, mathematics or a related field. The emphasis of the course is on in-depth understanding and analysis of concepts covered, with an extraordinary amount of home study required. Students are expected to complete a summer assignment given by the teacher. This course prepares students for two separate Advanced Placement Examinations in Calculus Based Physics: Mechanics and Electricity & Magnetism— which all students are required to take. AP Physics is a standard University level course (first or second year) for science and/or engineering students. The ability to understand and analyze the structure and the dynamics of the universe is emphasized. While students in Advanced Placement Physics study many of the topics of Physics I and Advanced Physics, they proceed with greater independence of thought and develop a great deal more insight into the realm of physics by engaging in a more sophisticated approach to the topics under study. Assessment tools will include tests, quizzes, homework, experiment-designs, written and verbal analysis of a topic or reading, and presentations. Students taking this course are given opportunities to do further independent study involving advanced topics in physics and multivariable calculus with applications to physical science. The student requesting A.P. Physics must have a complete commitment to learning physics with excellent study skills and must possess a strong command of mathematics up to Calculus.

Goals:
This course ordinarily forms the first part of the college sequence that serves as the foundation in physics for students majoring in the physical sciences or engineering. The sequence is parallel to or preceded by mathematics courses that include calculus. Methods of calculus are used wherever appropriate in formulating physical principles and in applying them to physical problems. The sequence is more intensive and analytic than that in the B course. Strong emphasis is placed on solving a variety of challenging problems, some requiring calculus. The subject matter of the C course is principally mechanics and electricity and magnetism, with approximately equal emphasis on these two areas. The C course is the first part of a sequence which in college is sometimes a very intensive one-year course but often extends over one and one-half to two years, with a laboratory component.

Topic Outline:
In the typical Physics C course, roughly one-half year is devoted to mechanics. Use of calculus in problem solving and in derivations is expected to increase as the course progresses. In the second half-year of the C course, the primary emphasis is on classical electricity and magnetism. Calculus is used freely in formulating principles and in solving problems. The topic outline for each area can be seen in the table on the next page:

1. **Newtonian Mechanics (50%)**

2. **Electricity and Magnetism (50%)**

Most colleges and universities include additional topics such as wave motion, thermal physics, optics, alternating current circuits, or special relativity in a C course. Although wave motion, optics, and thermal
physics are usually the most commonly included, there is little uniformity among such offerings, and these topics are not included in the Physics C examination. The Development Committee recommends that supplementary material be added to a Physics C course when possible. Many teachers have found that a good time to do this is late in the year, after the AP Exams have been given.

**Comparison of Topics in Physics B and Physics C**

The table below identifies the content of the Physics B and C Exams. These percentages indicate the approximate weighting of the major categories for the entire exam. For each category, important subtopics are listed. Questions for the examination will come from these subtopics, but not all of the subtopics will necessarily be included in every examination, just as they are not necessarily included in every AP or college course.

Please note: Although fewer topics are covered in Physics C than in Physics B, they are covered in greater depth and with greater analytical and mathematical sophistication, including calculus applications.

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Percentage Goals for Examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Newtonian Mechanics</strong></td>
<td>Physics B</td>
</tr>
<tr>
<td>A. Kinematics (including vectors, vector algebra, components of vectors, coordinate systems, displacement, velocity, and acceleration)</td>
<td>35%</td>
</tr>
<tr>
<td>Motion in one dimension</td>
<td>7%</td>
</tr>
<tr>
<td>Motion in two dimensions including projectile motion</td>
<td>9%</td>
</tr>
<tr>
<td>B. Newton's laws of motion</td>
<td>5%</td>
</tr>
<tr>
<td>Static equilibrium (first law)</td>
<td>9%</td>
</tr>
<tr>
<td>Dynamics of a single particle (second law)</td>
<td>7%</td>
</tr>
<tr>
<td>Systems of two or more bodies (third law)</td>
<td>4%</td>
</tr>
<tr>
<td>C. Work, energy, power</td>
<td>4%</td>
</tr>
<tr>
<td>Work and work-energy theorem</td>
<td>5%</td>
</tr>
<tr>
<td>Forces and potential energy</td>
<td>7%</td>
</tr>
<tr>
<td>Conservation of energy</td>
<td>9%</td>
</tr>
<tr>
<td>Power</td>
<td>9%</td>
</tr>
<tr>
<td>D. Systems of particles, linear momentum</td>
<td>4%</td>
</tr>
<tr>
<td>Center of mass</td>
<td>9%</td>
</tr>
<tr>
<td>Impulse and momentum</td>
<td>7%</td>
</tr>
<tr>
<td>Conservation of linear momentum, collisions</td>
<td>9%</td>
</tr>
<tr>
<td>E. Circular motion and rotation</td>
<td>4%</td>
</tr>
<tr>
<td>19. Uniform circular motion</td>
<td>9%</td>
</tr>
<tr>
<td>20. Torque and rotational statics</td>
<td>7%</td>
</tr>
<tr>
<td>21. Rotational kinematics and dynamics</td>
<td>9%</td>
</tr>
<tr>
<td>22. Angular momentum and its conservation</td>
<td>11%</td>
</tr>
<tr>
<td>F. Oscillations and gravitation</td>
<td>6%</td>
</tr>
<tr>
<td>Simple harmonic motion (dynamics and energy relationships)</td>
<td>9%</td>
</tr>
<tr>
<td>Mass on a spring</td>
<td>11%</td>
</tr>
<tr>
<td>Pendulum and other oscillations</td>
<td>13%</td>
</tr>
</tbody>
</table>
- Newton's law of gravity
- Orbits of planets and satellites
  - Circular
  - General

<table>
<thead>
<tr>
<th>II. Fluid Mechanics and Thermal Physics</th>
<th>15%</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Fluid Mechanics</td>
<td></td>
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</tr>
<tr>
<td>Hydrostatic pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buoyancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid flow continuity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bernoulli's equation</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>B. Temperature and heat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical equivalent of heat</td>
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<td></td>
</tr>
<tr>
<td>Heat transfer and thermal expansion</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>C. Kinetic theory and thermodynamics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideal gases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinetic model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideal gas law</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laws of thermodynamics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First law (including processes on pV diagrams)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second law (including heat engines)</td>
<td>7%</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III. Electricity and Magnetism</th>
<th>25%</th>
<th>50%</th>
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</thead>
<tbody>
<tr>
<td>A. Electrostatics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge and Coulomb's law</td>
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<td></td>
</tr>
<tr>
<td>Electric field and electric potential (including point charges)</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td>Gauss's law</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fields and potentials of other charge distributions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Conductors, capacitors, dielectrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrostatics with conductors</td>
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<td></td>
</tr>
<tr>
<td>Capacitors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacitance</td>
<td></td>
<td></td>
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<tr>
<td>Parallel plate</td>
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<td></td>
</tr>
<tr>
<td>Spherical and cylindrical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dielectrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Electric circuits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current, resistance, power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steady-state direct current circuits with batteries and resistors only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacitors in circuits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steady state</td>
<td></td>
<td></td>
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<tr>
<td>Transients in RC circuits</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>D. Magnetic Fields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forces on moving charges in magnetic fields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forces on current-carrying wires in magnetic fields</td>
<td>4%</td>
<td>7%</td>
</tr>
<tr>
<td>Fields of long current-carrying wires</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biot-Savart's law and Ampere's law</td>
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</tr>
<tr>
<td>E. Electromagnetism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electromagnetic induction (including Faraday's law and Lenz's law)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inductance (including LR and LC circuits)</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Maxwell's equations</td>
<td></td>
<td></td>
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<tr>
<td>IV. Waves and Optics</td>
<td>15%</td>
<td>N/A</td>
</tr>
<tr>
<td>A. Wave motion (including sound)</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Traveling waves</td>
<td>Wave propagation</td>
<td>Standing waves</td>
</tr>
<tr>
<td>----------------</td>
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</tr>
<tr>
<td>B. Physical optics</td>
<td>Interference and diffraction</td>
<td>Dispersion of light and the electromagnetic spectrum</td>
</tr>
<tr>
<td>C. Geometric optics</td>
<td>Reflection and refraction</td>
<td>Mirrors</td>
</tr>
<tr>
<td>V. Atomic and Nuclear Physics</td>
<td>10%</td>
<td>N/A</td>
</tr>
<tr>
<td>A. Atomic physics and quantum effects</td>
<td>Photons, the photoelectric effect, Compton scattering, x-rays</td>
<td>Atomic energy levels</td>
</tr>
<tr>
<td>B. Nuclear physics</td>
<td>Nuclear reactions (including conservation of mass number and charge)</td>
<td>Mass-energy equivalence</td>
</tr>
</tbody>
</table>
There are the various strands that cross content.

They have relevance to every curricular area and all grade levels.

The strands are interwoven into content and integrated into instruction.
They do not stand alone.

A synopsis of each strand is included in this document.

The full SBSD K-12 District Appendix, with detailed information about each strand, can be found as a separate document.

**Topics**
- Teaching for the 21st Century
- Educational Technology Standards
- 21st Century Life and Career Education Skills
- Character Education
- Differentiation
- Understanding by Design (UbD): “Reader’s Digest” Version
### Topic

**Teaching for the 21st Century:**
What does this mean and how do you do it?

Students need to gain skills that will enable them to learn on their own, think critically and creatively, and apply knowledge to new situations. An emphasis needs to be placed on problem solving, teamwork skills, global awareness, and proficiency in using technology. Students need to learn to collaborate and work on authentic problems that they will likely encounter in their future careers. This section will outline what this means and how you “teach” for the 21st century: Elementary, Middle and High.

### Tools for the 21st Century:
Life, Careers, and Digital Environments

21st Century Life and Career Education Skills and Educational Technology Skills outline the NJ Core Curriculum Content Standards for these areas that align with PK-12 learning.

These standards are written into the curriculum documents for all areas of content—English Language Arts, Mathematics, Science, Social Studies, PE/Health Education, Visual Art, Music, World Language and Library-Media. They are integrated into curriculum and instruction in places where it is relevant and meaningful to do so, and in ways that enhance learning. You will see these integrations explicitly noted in the curriculum guides: Elementary, Middle and High.

### Character Education:
Safe and Caring Learning Communities

South Brunswick takes an “approach” to character education that fosters the social, emotional and academic growth of each child. The intent is to create a safe and caring community while building life skills based on the five core values (CARES):

- C  Cooperation
- A  Assertion
- R  Responsibility (and Respect)
- E  Empathy
- S  Self-Control

For over ten years, the K-5 teachers have been trained in and have followed the *Responsive Classroom (RC)* approach.

The middle school teachers have studied and/or been trained in the *Developmental Designs (DD)*
approach to character education.

The high school approach has been named “Strive for Five” and includes an annual theme with related activities to bring Character Education to the forefront. There is always a service-learning project connected to the theme. In addition, the high school also follows the Institute of Excellence and Ethics (IEE) approach. The IEE approach allows for explicit teaching of Character Education through a series of multimedia lessons that are embedded into the students’ schedules.

**Differentiation**

Differentiation of instruction is a deliberate and conscious method of planning and teaching that provides multiple avenues of learning. It means different challenges to different students. It is characterized by strategies that use an assessment of each individual student for readiness, interest and learning style to modify instruction in three ways: by content, process and product.

In this document, there is a brief description of several approaches and methods that have long been utilized in South Brunswick to meet the differentiated needs of students within the classroom.

- Bloom’s Taxonomy
- Gardner’s Multiple Intelligences
- Learning Styles
- Inclusion Classrooms
- Kagan Cooperative Learning
- Principles of Differentiation

It is expected that classroom instruction will be differentiated. This expectation is predicated upon the belief or disposition that “all students can learn.”

**Understanding by Design**

For nearly two decades, the South Brunswick School District has held much value in the Understanding by Design (UbD) or Backward Design model of curriculum writing by Grant Wiggins. This model and the process of curriculum development, has been used in the district for many years. The curriculum template—which was recommended by the State of NJ and adopted/adapted by the District, includes elements of the UbD approach.)

You will note that in every curricular area, we begin with the end in mind (that is, the big idea). Enduring understandings, essential questions and performance assessments—all based on standards-are used in the process of curriculum development.

With this being said, it is not only important to understand the process of UbD, but also how to implement curriculum designed in such a way.

A brief overview of how to use Understanding by Design in delivering curriculum is included in the Appendix.